UNIVERSITY of MARYLAND
THE FOUNDING CAMPUS

ADMINISTRATION & FINANCE

OFFICE OF FACILITIES MANAGEMENT

SPECIFICATIONS FOR THE DESIGN OF CAMPUS ELECTRICAL DISTRIBUTION AT THE UNIVERSITY OF MARYLAND

UNIVERSITY PROJECT # 17-317

BID DOCUMENTS – PHASES 1C

VOLUME 1 OF 1: PROJECT SPECFICATIONS

AUGUST 24, 2020

Owner
University of Maryland, Baltimore
Office of Facilities Management
Design and Construction
220 Arch Street, Office Level 3, 14th Floor
Baltimore, Maryland 21201

Board of Public Works
Lawrence J. Hogan Jr., Governor
Peter Franchot, Comptroller
Nancy K. Kopp, Treasurer

Maryland General Assembly
Bill Ferguson, Senate President
Adrienne A. Jones, House Speaker

Architect
Gaudreau (Ewing Cole)
810 Light Street
Baltimore, MD 21230

Civil/Site Engineer
Carroll Engineering, Inc.
215 Schilling Circle
Hunt Valley, MD 21031

Structural Engineer
Carroll Engineering, Inc.
215 Schilling Circle
Hunt Valley, MD 21031

MEP Engineer
RMF Engineering, Inc.
5520 Research Park Drive
Baltimore, MD 21228

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SECTION 01010 - SUMMARY OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. The Project consists of mainly electrical work across the entire campus which will be provided by the contractor. The project has been organized into three packages under one contract:

1. Package A: North Switching Station: The work under this package to be performed by the contractor includes providing four switchgear lineups in the North Station. The North Station is a newly constructed building that is not included in the scope of this project. An additional 15 kV generator paralleling switchgear lineup will be provided by the contractor under the A Package within Howard Hall. A new switchgear control system will be provided by the contractor that will control and monitor the North Station, Howard Hall, and Peaking Plant 15 kV equipment.

   The contractor will provide 15 kV distribution feeders and generation feeders from the North Station and Peaking Plant to the new switchgear provided in Howard Hall. Five total BGE feeders (four for UMB and one for the University of Maryland Medical Center) and associated fiber optic cable from the BGE Paca Street substation to the UMB North Station will be provided by BGE through existing ductbank and shall be coordinated by the contractor.

2. Package B: Howard Hall and Bressler Research Building: The work under this package to be provided by the contractor includes replacing the existing 480 V main building switchgears in Howard Hall and Bressler Research Building and the 4,160 V chiller switchgear in Bressler Research Building. The contractor will provide the Howard Hall Main 15 kV switchgear.

3. Package C: MSTF: The work under this package to be provided by the contractor includes the replacement of the HSF-1 480 V Generator Switchgear with a new paralleling switchgear configured as a main-tie-main. This new HSF1 equipment will utilize the two (2) existing 750kW generators in HSF1 to provide Life-Safety emergency generator power back-up to HSF1, Howard Hall, Bressler Research Building, and MSTF. The exiting generators located in MSFT will be removed and all existing generator loads will be relocated to a dedicated life-safety load riser for the HSF1 connection. The contractor will provide an additional natural gas generator at the Peaking Plant including and all associated auxiliary

equipment to provide a new natural gas line from the existing tap at that location. The Peaking Plant controls system will be replaced by the contractor with a new local control panel and will communicate with the North Switching Station and contain provisions to receive communication from the South Switching Station in the future.

4. Project Location: University of Maryland, Baltimore

5. Owner: University of Maryland, Baltimore.

B. Contract Documents, dated January 31, 2019 were prepared for the Project by:
   1. RMF Engineering: 5520 Research Park Drive, Baltimore, MD 21228
   2. Carroll Engineering, Inc.: 215 Schilling Circle, Hunt Valley, MD 21031.
   3. Gaudreau, Inc.: 810 Light Street #300, Baltimore, MD 21230.

1.3 CONTRACTOR USE OF PREMISES

A. General: During the construction period the Contractor shall have full use of the premises for construction operations, including use of the site. The Contractor's use of the premises is limited only by the University's right to perform work or to retain other contractors on portions of the Project.

B. Use of the Site: Limit use of the premises to work in areas indicated. Confine operations to areas within contract limits indicated. Do not disturb portions of the site beyond the areas in which the Work is indicated.

   1. University Occupancy: Allow for University occupancy and use by the public.
   2. Driveways and Entrances: Keep driveways and entrances serving the premises clear and available to the University, the University's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

C. Use of the Existing Building: Maintain the existing building in a weathertight condition throughout the construction period. Repair damage caused by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period.

1.4 OCCUPANCY REQUIREMENTS

A. Full University Occupancy: The University will occupy the site and existing building during the entire construction period. Cooperate with the University during construction operations to minimize conflicts and facilitate University usage. Perform the Work so as not to interfere with the University's operations.

1. Off Hours Work: All building outages will need to occur during off hours. This includes all building power switchovers and individual load or equipment outages.

1.5 PROTECTION OF EXISTING CONSTRUCTION AND FURNISHINGS

A. The Contractor shall take all necessary precautions to protect the University's property and furnishings. The Contractor shall promptly remedy damage and loss to the University's property caused in whole or in part by the Contractor, a Subcontractor, a Sub-Subcontractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable and for which the Contractor is responsible.

PART 2 - PRODUCTS (Not Applicable)

PART 3 – EXECUTION (Not Applicable)

END OF SECTION 01010

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SECTION 01027 - APPLICATIONS FOR PAYMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements governing the Contractor's Applications for Payment.

B. This Section specifies administrative and procedural requirements governing each prime contractor's Applications for Payment.

1. Coordinate the Schedule of Values and Applications for Payment with the Contractor's Construction Schedule, Submittal Schedule, and List of Subcontracts.

C. Related Sections: The following Sections contain requirements that relate to this Section.

1. Schedules: The Contractor's Construction Schedule and Submittal Schedule are specified in Division 1 Section "Submittals."

1.3 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the Schedule of Values with preparation of the Contractor's Construction Schedule.

1. Correlate line items in the Schedule of Values with other required administrative schedules and forms, including:
   a. Contractor's Construction Schedule.
   b. Application for Payment forms, including Continuation Sheets.
   c. List of subcontractors.
   d. Schedule of allowances.
   e. Schedule of alternates.
   f. List of products.
   g. List of principal suppliers and fabricators.
   h. Schedule of submittals.

2. Submit the Schedule of Values to the University at the earliest possible date but no later than 7 days before the date scheduled for submittal of the initial Applications for Payment.

3. Subschedules: Where Work is separated into phases requiring separately phased payments, provide subschedules showing values correlated with each phase of payment.

B. Format and Content: Use the Project Manual table of contents as a guide to establish the format 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. University's Project number.
   c. Contractor's name and address.
   d. Date of submittal.
2. 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 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.
   h. Percentage of Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
3. Provide a breakdown of the Contract Sum in sufficient detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Break principal subcontract amounts down into several line items.
4. Round amounts to nearest whole dollar; the total shall equal the Contract Sum.
5. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment, purchased or fabricated and stored, but not yet installed.
   a. Differentiate between items stored on-site and items stored off-site. Include requirements for insurance and bonded warehousing, if required.
6. Provide separate line items on the Schedule of Values for initial cost of the materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
7. Margins of Cost: Show line items for indirect costs and margins on actual costs only when such items are listed individually in Applications for Payment. Each item in the Schedule of Values and Applications for Payment shall be complete. Include the total cost and proportionate share of general overhead and profit margin for each item.

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

8. Schedule Updating: Update and resubmit the Schedule of Values prior to the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.4 APPLICATIONS FOR PAYMENT

A. Each Application for Payment shall be consistent with previous applications for payment as paid for by the University.

1. The initial Application for Payment, the Application for Payment at time of Substantial Completion, and the final Application for Payment involve additional requirements.

B. Refer to the University of Maryland Baltimore Standard General Condition of Construction for requirements and procedures governing applications for payment.

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

1. List of subcontractors.
2. List of principal suppliers and fabricators.
3. Schedule of Values.
4. Contractor's Construction Schedule.
5. Schedule of principal products.
6. Schedule of unit prices.
7. Submittal Schedule.
8. List of Contractor's staff assignments.
9. List of Contractor's principal consultants.
10. Copies of authorizations and licenses from governing authorities for performance of the Work.
11. Initial progress report.
12. Report of preconstruction meeting.
13. Certificates of insurance and insurance policies.
14. Performance and payment bonds.
15. Data needed to acquire the University's insurance.
16. Initial settlement survey and damage report, if required.

D. Application for Payment at Substantial Completion: Following issuance of the Certificate of Substantial Completion, submit an Application for Payment.

1. This application shall reflect Certificates of Partial Substantial Completion issued previously for University occupancy of designated portions of the Work.
2. Administrative actions and submittals that shall precede or coincide with this application include:
    a. Warranties (guarantees) and maintenance agreements.
    b. Test/adjust/balance reports.
    c. Operation and Maintenance Manuals.
    d. Meter readings if appropriate.
    e. Startup performance reports.
    f. Commissioning Reports.
    g. Final cleaning.
    h. Application for reduction of retainage and consent of surety.
    i. Advice on shifting insurance coverages.
    j. Final progress photographs.
    k. List of incomplete Work, recognized as exceptions to University's Certificate of Substantial Completion.

E. Final Payment Application: Administrative actions and submittals that must precede or coincide with submittal of the final Application for Payment include the following:

1. Completion of Project closeout requirements.
2. Completion of items specified for completion after Substantial Completion.
3. Resolve all previously unsettled claims.
4. Resolve all previously incomplete Work.
5. Transmittal of required Project construction records to the University.
6. Proof that taxes, fees, and similar obligations were paid.
7. Removal of temporary facilities and services.
8. Removal of surplus materials, rubbish, and similar elements.
9. Change of door locks to University's access.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01027

SECTION 01035 - MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for handling and processing contract modifications.

1.3 MINOR CHANGES IN THE WORK

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

1.4 CHANGE ORDER PROPOSAL REQUESTS

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

1. Proposal requests issued by the University are for information only. Do not consider them as an instruction either to stop work in progress or to execute the proposed change.
2. Within a mutually agreed upon time period, submit an estimate of cost necessary to execute the change to the University for review.
    a. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities. Include required labor hours and unit costs, with totals for each labor category. Include all credits for deleted work.
    b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts, for new work and deleted work.
    c. Include a statement indicating the effect the proposed change in the Work will have on the Contract Time.

B. Contractor-Initiated Proposals: When latent or unforseen conditions require modifications to the Contract, the Contractor may propose changes by submitting a request for a change to the University.

1. Include a statement outlining the 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 Contract Time.
2. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities. Include required labor hours and unit costs, with totals for each labor category. Include all credits for deleted work.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts, for new work and deleted work.
4. Comply with requirements in Section "Product Substitutions" if the proposed change requires substitution of one product or system for a product or system specified.

C. Proposal Request Form: Use forms provided by the Owner for Change Order Proposals.

1.5 CHANGE ORDER PROCEDURES

A. Upon the University's approval of a Proposal Request, the University will issue a Change Order Requisition for signatures of the Contractor followed by a Notice to Proceed.

PART 2 - PRODUCTS (Not Applicable)

END OF SECTION 01035

SECTION 01040 - COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and supervisory requirements necessary for coordinating construction operations including, but not necessarily limited to, the following:

1. General project coordination procedures.
2. Conservation.
3. Coordination Drawings.
4. Administrative and supervisory personnel.
5. Cleaning and protection.

1.3 COORDINATION

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

1. Schedule construction operations in the 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 assure required minimum accessibility for maintenance, service, and repair.
3. Make provisions to accommodate items scheduled for later installation.

B. Where necessary, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and attendance at meetings.

1. Prepare similar memoranda for the University and sub-contractors where 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 assure orderly

progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of CPM schedules.
2. Installation and removal of temporary facilities.
3. Delivery and processing of submittals.
4. Progress meetings.
5. Work coordination meetings.
6. Project closeout activities.

D. Conservation: Coordinate construction operations to assure that operations are carried out with consideration given to conservation of energy, water, and materials.

1. Salvage materials and equipment involved in performance of, but not actually incorporated in, the Work.

1.4 SUBMITTALS

A. Coordination Drawings: Prepare coordination drawings where careful coordination is needed for installation of products and materials fabricated by separate entities. Prepare coordination drawings where limited space availability necessitates maximum utilization of space for efficient installation of different components. At a minimum, prepare coordination drawings for all mechanical rooms, electrical rooms and substation rooms.

1. Show the relationship of components shown on separate Shop Drawings.
2. Indicate required installation sequences.
3. Comply with requirements contained in Section "Submittals."
4. The coordination drawings shall be comprehensive drawings that show all work by all disciplines for each location on a single drawing. The drawings shall be prepared at a large enough scale to permit legibility and ease of recognition of all work.

B. Staff Names: Within 15 days of commencement of construction operations, submit a list of the Contractor's principal staff assignments, including the superintendent and other personnel in attendance at the Project Site. Identify individuals and their duties and responsibilities. List their addresses and telephone numbers.

1. Post copies of the list in the Project meeting room, the temporary field office, and at each temporary telephone.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 GENERAL COORDINATION PROVISIONS

A. Inspection of Conditions: Require the Installer of each major component to inspect both the substrate and conditions under which Work is to be performed. Do not proceed until unsatisfactory conditions have been corrected in an acceptable manner.

B. Coordinate temporary enclosures with required inspections and tests to minimize the necessity of uncovering completed construction for that purpose.

3.2 CLEANING AND PROTECTION

A. Clean and protect construction in progress and adjoining materials in place, during handling and installation. Apply protective covering where required to assure protection from damage or deterioration until Substantial Completion.

B. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to assure operability without damaging effects.

C. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period. Where applicable, such exposures include, but are not limited to, the following:

1. Excessive static or dynamic loading.
2. Excessive internal or external pressures.
3. Air contamination or pollution.
4. Water or ice.
5. Puncture.
6. Abrasion.
7. Heavy traffic.
8. Soiling, staining, and corrosion.
9. Combustion.
10. Electrical current.
11. Improper lubrication.
12. Unusual wear or other misuse.
13. Contact between incompatible materials.
14. Destructive testing.
15. Misalignment.
16. Excessive weathering.
17. Unprotected storage.
18. Improper shipping or handling.
19. Theft.
20. Vandalism.

END OF SECTION 01040

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SECTION 01045 - CUTTING AND PATCHING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for cutting and patching.

1.3 SUBMITTALS

A. Cutting and Patching Proposal: When unforeseen conditions require cutting and patching of the existing structure and/or related components the CM shall submit a cutting and patching proposal to the university, for review and approval before proceeding with any work. Include the following information, as applicable, in the proposal:

1. Describe the extent of cutting and patching required and indicate why it cannot be avoided. Include changes to the building's appearance and other significant visual elements if applicable.
2. Describe the products to be used.
3. Identify the impact to the project's schedule and budget.
4. Indicate the dates when cutting and patching will be performed.
5. Where cutting and patching involves adding reinforcement to structural elements, the modifications to the structure shall be designed by a registered structural engineer. If the design team does not include a structural engineer the CM shall secure the services of an engineer to perform the required design. The CM shall submit the design drawings, details and engineering calculations showing integration of reinforcement with the original structure to the University.
6. Approval by the University to proceed with cutting and patching does not waive the University's right to later require complete removal and replacement of unsatisfactory work.

1.4 QUALITY ASSURANCE

A. Requirements for Structural Work: Do not cut and patch structural elements in a manner that would change their load-carrying capacity or load-deflection ratio.

1. Obtain hot work permit from the University for cutting, burning, welding, etc.
2. Obtain approval of the cutting and patching proposal before cutting and patching the following structural elements:

a. Foundation construction.
b. Bearing and retaining walls.
c. Structural concrete.
d. Structural steel.
e. Lintels.
f. Timber and primary wood framing.
g. Structural decking.
h. Stair systems.
i. Miscellaneous structural metals.
j. Exterior curtain-wall construction.
k. Equipment supports.
l. Piping, ductwork, vessels, and equipment.
m. Structural systems of special construction in Division 13 Sections.

B. Operational Limitations: Do not cut and patch operating elements or related components in a manner that would result in reducing their capacity to perform as intended. Do not cut and patch operating elements or related components in a manner that would result in increased maintenance or decreased operational life or safety.
1. Obtain approval of the cutting and patching proposal from the University before cutting and patching the following operating elements or safety related systems:
a. Primary operational systems and equipment.
b. Air or smoke barriers.
c. Water, moisture, or vapor barriers.
d. Membranes and flashings.
e. Fire protection systems.
f. Noise and vibration control elements and systems.
g. Control systems.
h. Communication systems.
i. Conveying systems.
j. Electrical wiring systems.
k. Operating systems of special construction.

C. Visual Requirements: Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in the University's opinion, reduce the building's aesthetic qualities. Do not cut and patch construction in a manner that would result in visual evidence of cutting and patching. Remove and replace construction cut and patched in a visually unsatisfactory manner when directed by the University.

1. If possible, retain the original Installer or fabricator to cut and patch the exposed Work listed below. If it is impossible to engage the original Installer or fabricator, engage another recognized experienced and specialized firm.
a. Processed concrete finishes.
b. Stonework and stone masonry.
c. Ornamental metal.

d. Matched-veneer woodwork.
e. Preformed metal panels.
f. Firestopping.
g. Window wall system.
h. Stucco and ornamental plaster.
i. Acoustical ceilings.
j. Terrazzo.
k. Finished wood flooring.
l. Fluid-applied flooring.
m. Carpeting.
n. Aggregate wall coating.
o. Wall covering.
p. HVAC enclosures, cabinets, or covers.

1.5 WARRANTY

A. Existing Warranties: Replace, patch, and repair material and surfaces cut or damaged by methods and with materials in such a manner as not to void any warranties required or existing.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible if identical materials are unavailable or cannot be used. Use materials whose installed performance will equal or surpass that of existing materials. Refer to applicable spec sections for materials.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching is to be performed before cutting. If unsafe or unsatisfactory conditions are encountered, take corrective action before proceeding.

3.2 PREPARATION

A. Temporary Support: Provide temporary support of work to be cut.

B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project that might be exposed during cutting and patching operations.

C. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Avoid cutting existing pipe, conduit, or ductwork serving the building but scheduled to be removed or relocated until provisions have been made to bypass them or to take them out of service.

3.3 PERFORMANCE

A. General: Employ skilled workmen or experienced subcontractors to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay.

1. Cut existing construction to provide for installation of other components or performance of other construction activities and the subsequent fitting and patching required to restore surfaces to their original condition.

B. Cutting: Cut existing construction using methods least likely to damage elements retained or adjoining construction. Where possible, review proposed procedures with the original Installer; comply with the original Installer's recommendations.

1. In general, when cutting, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. To avoid marring existing finished surfaces, cut or drill from the exposed or finished side into concealed surfaces.
3. Cut through concrete and masonry using a cutting machine, such as a Carborundum saw or a diamond-core drill.
4. Comply with requirements of applicable Division 2 Sections where cutting and patching requires excavating and backfilling.
5. Where services are required to be removed, relocated, or abandoned, by-pass utility services, such as pipe or conduit, before cutting. Ensure all services have been de-energized or drained before cutting. Cut-off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal the remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after by-passing and cutting.

C. Patching: Patch with durable seams that are as invisible as possible. Comply with specified tolerances.

1. Where feasible, inspect and test patched areas to demonstrate integrity of the installation.

2. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
3. Where removing walls or partitions extends one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform color and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
    a. Where patching occurs in a smooth painted surface, extend final paint coat over entire unbroken surface containing the patch after the area has received primer and second coat. Prepare entire surface to receive final coat as necessary for proper adhesion.
4. Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

D. Plaster Installation: Comply with manufacturer's instructions and install thickness and coats as indicated.

1. Unless otherwise indicated, provide 3-coat work.
2. Finish gypsum plaster to match existing adjacent surfaces. Sand lightly to remove trowel marks and arises.
3. Cut, patch, point-up, and repair plaster to accommodate other construction.

3.4 LEANING

A. Areas and spaces where cutting, and patching are performed shall be cleaned. Completely remove paint, mortar, oils, putty, and similar items. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.

END OF SECTION 01045

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SECTION 01095 - REFERENCE STANDARDS AND DEFINITIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 DEFINITIONS

A. General: Basic contract definitions are included in the Conditions of the Contract.

B. "Indicated": The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, or other paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Terms such as "shown," "noted," "scheduled," and "specified" are used to help the reader locate the reference. Location is not limited.

C. "Directed": Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean directed by the University, requested by the University, and similar phrases.

D. "Approved": The term "approved," when used in conjunction with the University's action on the Contractor's submittals, applications, and requests, is limited to the University's duties and responsibilities as stated in the Conditions of the Contract.

E. "Regulations": The term "regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": The term "furnish" means supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": The term "install" describes operations at the Project Site including the actual unloading, unpacking, assembly, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

H. "Provide": The term "provide" means to furnish and install, complete and ready for the intended use.

I. "Installer": An installer is the Contractor or another entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier, to perform a particular construction activity, including installation, erection, application, or similar operations. Installers are required to be experienced in the operations they are engaged to perform.

1. The term "experienced," when used with the term "installer," means having a minimum of 5 previous projects similar in size and scope to this Project, being familiar with the special requirements indicated, and having complied with requirements of authorities having jurisdiction.
2. Trades: Using terms such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespersons of the corresponding generic name.

J. “Project Site" is the space available to the Contractor for performing construction activities, either exclusively or in conjunction, with others performing other work as part of the Project. The extent of the Project Site is shown on the Drawings and may or may not be identical with the description of the land on which the Project is to be built.

K. “Testing Agencies": A testing agency is an independent entity engaged to perform specific inspections or tests, either at the Project Site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Except where 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 the standards in effect as of the date of the Contract Documents.

C. Conflicting Requirements: Where compliance with 2 or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer to the University before proceeding for a decision on requirements that are different but apparently equal, and where it is uncertain which requirement is the most stringent.

1. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum acceptable. 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 the requirements. Refer uncertainties to the University for a decision before proceeding.

D. Copies of Standards: Each entity engaged in construction on the Project is required to 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, the Contractor shall obtain copies directly from the publication source.

E. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where such acronyms or abbreviations are used in the Specifications or other Contract Documents, they mean the recognized name of the trade association, standards-generating organization, authorities having jurisdiction, or other entity applicable to the context of the text provision. Refer to Gale Research Co.'s "Encyclopedia of Associations," available in most libraries.

1.4 SUBMITTALS

A. Permits, Licenses, and Certificates: For the University's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established in conjunction with compliance with standards and regulations bearing upon performance of the Work.

PART 1 - PRODUCTS (Not Applicable)

PART 2 - EXECUTION (Not Applicable)

END OF SECTION 01095

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SECTION 01200 - PROJECT MEETINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for project meetings, including, but not limited to, the following:
   1. Preconstruction conferences.
   2. Progress meetings.

1.3 PRECONSTRUCTION CONFERENCE

A. The University shall schedule a preconstruction conference before starting construction, at a time convenient to the Contractor and the University, but no later than 15 days after execution of the Agreement. The conference will be held at a site identified by the University.

   1. The University will conduct the meeting. Minutes will be recorded and distributed to participants in accordance with contract requirements.

B. Attendees: Authorized representatives of the University, University, and their consultants; the Contractor and its superintendent; major subcontractors; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with the Project and authorized to conclude matters relating to the Work.

C. Agenda: Discuss items of significance that could affect progress, including, but not limited to, the following:

   1. Tentative construction schedule.
   2. Critical work sequencing.
   3. Designation of responsible personnel.
   4. Procedures for processing field decisions and Change Orders.
   5. Procedures for processing Applications for Payment.
   6. Procedures for processing Requests for Information (RFI's).
   7. Procedures for processing University's Supplemental Instructions and Contract Clarification.
   8. Distribution of Contract Documents.
   9. Submittal of Shop Drawings, Product Data, and Samples.
   10. Preparation of record documents.

11. Use of the premises.
12. Parking availability.
13. Office, work, and storage areas.
14. Equipment deliveries and priorities.
15. Safety procedures.
16. First aid.
17. Security.
18. Housekeeping.
19. Working hours.
20. Utility outages.
21. Testing.

1.4 PROGRESS MEETINGS

A. The University shall schedule and administer bi-weekly progress meetings throughout the progress of work. The progress meetings will be held at a site identified by the University.

1. The University will conduct the meeting, record minutes, and distribute copies to participants.

B. Attendees: In addition to representatives of the University and the University, each subcontractor, or 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 conference shall be familiar with the Project and authorized to conclude matters relating to the Work.

C. Agenda: Review and correct or approve minutes of the previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to the status of the Project.

1. Contractor's CPM Construction Schedule: Review progress since the last meeting. Determine status of each activity in relation to the Contractor's Construction Schedule, whether on time, ahead or behind schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to insure that current and subsequent activities will be completed within the Contract Time. Determine status of tasks on critical path. Identify additional tasks becoming critical due to delays.
2. Review the present and future needs of each entity present, including, but not limited to, the following:
   a. Interface requirements.
   b. Time.
   c. Sequences.
   d. Status of submittals.
   e. Deliveries.

f. Off-site fabrication problems.
g. Access.
h. Site utilization.
i. Temporary facilities and services.
j. Hours of work.
k. Hazards and risks.
l. Housekeeping.
m. Quality and work standards.
n. Change Orders.
o. Documentation of information for payment requests.
p. Review submittal log.
q. Review RFI log.
r. Review Change Order log.
s. Review upcoming outages, testing and inspections.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01200

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SECTION 01300 - SUBMITTALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for all submittals, required for the installation and completion of the work for the project. Submittals include three (3) types of submittals, Construction Submittals, Administrative Submittals and Quality Control Submittals as defined hereinafter.

B. UM Standard Project Forms:

1. The CM, Contractors, and A/E shall use the following UM Standard Project Submittal Forms for all submissions as follows:

   a. UM Standard Project Submittal Form
   b. UM Standard Project RFI Form

2. These forms are included in Part 2 Products for reference and each form's individual electronic file is available at the UM Architecture Engineering and Construction Documents web site at http://www.umbfm.umaryland.edu then through the link for AEC and AEC Documents.

1.3 DEFINITIONS

A. Construction Submittals: Construction Submittals are defined as submittals which include all information related to products, materials, and equipment used for the construction of the project. Unless otherwise indicated all references to "Submittals" in the documents are for Construction Submittals. Construction Submittals: Such submittals shall include, but are not limited to, the following:
   1. Contractor's construction schedule.
   2. Submittal schedule.
   3. Daily construction reports.
   4. Shop Drawings.
   5. Product Data.
   6. Samples.
   7. Quality assurance submittals.
   8. Fabrication drawings.
   9. Installation drawings.

10. Setting diagrams.
11. Shopwork manufacturing instructions.
12. Templates and patterns.
13. Schedules.
14. Coordination drawings.
15. Requests for Information (RFI's).

B. Administrative Submittals: Administrative Submittals are defined as submittals which include all information related to administrative documentation for the project. Refer to other Division 1 Sections and other Contract Documents for requirements for administrative submittals. Such submittals shall include, but are not limited to, the following:
   1. Permits.
   2. Applications for Payment.
   3. Performance and payment bonds.
   4. Insurance certificates.
   5. List of subcontractors.

C. Quality Control Submittals: Quality-control submittals are defined as submittals which include all information related to administrative documentation for the project. Such submittals shall include, but are not limited to, the following:

   1. Design data.
   2. Certifications.
   3. Manufacturer's instructions.
   4. Manufacturer's field reports.

D. Coordination Drawings: Coordination Drawings show the relationship and integration of different construction elements that require careful coordination during fabrication or installation to fit in the space provided or to function as intended.

   1. Preparation of Coordination Drawings is specified in Division 1 Section "Coordination" and may include components previously shown in detail on Shop Drawings or Product Data.

E. Samples: Samples include, but are not limited to, the following:
   1. Partial Sections of manufactured or fabricated components.
   2. Small cuts or containers of materials.
   3. Complete units of repetitively used materials.
   4. Swatches showing color, texture, and pattern.
   5. Color range sets.
   6. Components used for independent inspection and testing.
   7. Field samples.
   8. Field mock-ups

F. Product Data: Product data shall include, but are not limited to, the following:

1. Manufacturer's product specifications.
2. Manufacturer's installation instructions.
3. Standard color charts.
4. Catalog cuts.
5. Roughing-in diagrams and templates.
6. Standard wiring diagrams.
7. Printed performance curves.
8. Operational range diagrams.
9. Mill reports.
10. Standard product operating and maintenance manuals.
11. Certified capacity and performance data.

1.4 GENERAL SUBMITTAL PROCEDURES

A. Submissions: UM requires that all construction and administration type submittals be transmitted electronically in "pdf" format for all products, materials, and equipment related to construction and all documentation related to the administration of the project. However UM will accept hard copies (paper copies) of construction and administration type submittals from the Contractor and CM when electronic files cannot be used.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay, and in accordance with the project CPM schedule.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.

2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.

   a. The University reserves the right to withhold action on a submittal requiring coordination with other submittals until all related submittals are received.

3. Scheduling: Division 1 Section "Schedules and Reports" includes the Submittal Schedule listing submittals and indicating time requirements for coordination of submittal activity with related construction operations.

4. Processing: To avoid the need to delay installation as a result of the time required to process submittals, allow sufficient time for submittal review, including time for resubmittals.

a. Allow four (4) weeks for initial review. Allow additional time if the University must delay processing to permit coordination with subsequent submittals.
b. If an intermediate submittal is necessary, process the same as the initial submittal.
c. Allow four (4) weeks for reprocessing each submittal.
d. No extension of Contract Time will be authorized because of failure to transmit submittals to the University sufficiently in advance of the Work to permit processing.
e. The Contractor and CM shall conduct an internal review of every submittal to ensure accuracy and completeness prior to submission to the A/E.

C. Submittal Preparation: The Contractor or CM shall attach the UM Standard Project Submittal Form to the electronic file for each submittal. The contractor or CM shall complete the upper portion of the forms as appropriate.

D. Submittal Transmittal: Include an electronic transmittal with each submittal file for transmittal and handling. Each submittal file shall be transmitted electronically from the Contractor to the CM, then to the A/E. Forward a copy of the electronic transmittal to the UM OFM Project Manager. The A/E and the University will not accept submittals received from sources other than the Contractor or CM.

1. On the transmittal, record relevant project information.
2. Include Contractor's certification that information submitted complies with Contract Document requirements.
3. Transmittal Form: Prepare. Use the UM Standard Submittal Transmittal Form. In the places on the form provide the following information:

a. Project name.
b. Date.
c. Destination (To:).
d. Source (From:).
e. Names of the subcontractor, manufacturer, and supplier.
f. Category and type of submittal.
g. Submittal purpose and description.
h. Submittal and transmittal distribution record.
i. Remarks.
j. Signature of transmitter.

E. Requests for Information (RFI's): Use the UM Standard RFI Form for all Requests for Information. The CM or contractor shall submit each RFI to the A/E and copy the UM OFM Project Manager.

F. Contractor's Construction Schedule: Refer To Division 1 Section CPM Schedules

G. Daily Construction Reports

1. Prepare a daily construction report recording the following information concerning events at the site, and submit duplicate copies to the University at weekly intervals:

   a. List of subcontractors at the site.
   b. Approximate count of personnel at the site.
   c. High and low temperatures, general weather conditions.
   d. Accidents and unusual events.
   e. Meetings and significant decisions.
   f. Stoppages, delays, shortages, and losses.
   g. Meter readings and similar recordings.
   h. Incident reports with emergency procedures followed.
   i. Orders and requests of governing authorities.
   j. Change Orders received, implemented.
   k. Services connected, disconnected.
   l. Equipment or system tests and startups.
   m. Partial Completions, occupancies.
   n. Substantial Completions authorized.

H. Shop Drawings and Coordinated Drawings

1. In addition to the general submittal procedures, the following requirements apply to shop drawings and coordination drawings:

   a. Submit newly prepared information drawn accurately to scale. Indicate deviations from the Contract Documents. The CM or contractor shall not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not a Shop Drawing.

2. Shop Drawings include fabrication and installation drawings, setting diagrams, schedules, patterns, templates and similar drawings. Include the following information:

   a. Dimensions.
   b. Identification of products and materials included by sheet and detail number.
   c. Compliance with specified standards.
   d. Notation of coordination requirements.
   e. Notation of dimensions established by field measurement.

3. Submit Coordination Drawings where required for integration of different construction elements, and in compliance with the requirements of Division 1

Section “Coordination”. Show construction sequences and relationships of separate components where necessary to avoid conflicts in utilization of the space available.

4. Sheet Size: Except for templates, patterns, and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches (215 by 280 mm) but no larger than 30 by 40 inches (750 by 1000 mm).

5. Hard Copy Submittals: When hard copy submittals are used submit one (1) reproducible drawing for review by the A/E. The A/E will review and make appropriate comments on the reproducible drawing, sign off the UM forms with action taken, make one (1) print for their record, and forward the reproducible drawing to the University. The University will review and make additional comments as necessary, forward their comments to the A/E for their record and information, make one (1) copy for their use and return the reproducible drawing to the Contractor. For submittals requiring resubmission, the process will be repeated until submittals are considered acceptable by the A/E and the University.

6. Electronic Submittals: When shop drawings are transmitted electronically, submit one (1) electronic file for each shop drawing. Each file shall include all required submittal data and the UM Submittal Form for each submittal. The A/E will review and make appropriate comments on the electronic file, sign off the UM forms with action taken, retain one (1) copy for their record, and forward the electronic file to the University. The University will review and make additional comments as necessary; forward their comments to the A/E for their record and information, retain one (1) copy of the electronic file for their use, and return the electronic file to the CM or Contractor. For submittals requiring resubmission, the process will be repeated until submittals are considered acceptable by the A/E and the University.

7. Shop Drawing shall not be used without an appropriate final stamp indicating the action taken.

I. Product Data

1. In addition to the general submittal procedures, the following requirements apply to product data submittals:

   a. Collect Product Data into a single submittal for each element of construction or system. Product Data shall include printed information, such as manufacturer's general product information, installation instructions, catalog cuts, standard color charts, roughing-in dimensions, diagrams and templates, standard wiring diagrams, and performance data and curves.

   b. Mark each copy to show applicable choices and options. Where printed product data includes information on several products that are either not

required or are optional materials, arrangements or components that require a selection or indicator, mark copies to indicate the applicable information. Include the following information:

1) Manufacturer's printed recommendations.
2) Compliance with trade association standards.
3) Compliance with recognized testing agency standards.
4) Application of testing agency labels and seals.
5) Notation of dimensions verified by field measurement.
6) Notation of coordination requirements.
7) Compliance with contract documents.
8) Specification Section and paragraph.

c. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.

d. Hard Copy Submittals: When hard copy submittals are used submit six (6) copies, plus the number required for the CM and Contractor's use, of each required submittal for review by the A/E. The A/E will review and make appropriate comments on each copy, sign off the UM forms with action taken, retain two (2) copies for their records and forward the remaining submittals to the University. The University will review the submittals, make additional comments as necessary, forward their comments to the A/E for their records, retain one (1) copy of each submittal, and return the remaining submittals to the Contractor. For submittals requiring resubmission, the process will be repeated until submittals are considered acceptable by the A/E and the University.

e. Electronic Submittals: When product data submittals are transmitted electronically, submit one (1) electronic file for each shop submittal. Each file shall include all required submittal data and the UM Submittal Form for each submittal. The A/E shall review and make appropriate comments on the electronic file, sign off the UM forms with action taken, retain one (1) copy for their record and forward the electronic file to the University. The University will review and make additional comments as necessary, sign off the UM forms, retain one (1) copy of the electronic file for their use, forward their comments to the A/E for their record and information, and return the electronic file to the CM or Contractor. For submittal files requiring resubmission, the process will be repeated until submittals are considered acceptable by the A/E and the University.

f. Distribution: Forward one (1) copy of each approved submittal file to installers, subcontractors, suppliers, manufacturers, fabricators, and others required for performance of construction activities. Show distribution on transmittal forms.

g. Do not proceed with installation until a copy of approved Product Data is in the Installer's possession.

h. Do not permit use of unmarked copies of Product Data in connection with construction.

i. The Contractor shall retain three (3) copies of the final submittals for inclusion in the O&M Manuals.

J. Samples

1. In addition to the general submittal procedures, the following requirements apply to samples:

a. Submit full-size, fully fabricated Samples cured and finished as specified and physically identical with the material or product designed and specified. Samples include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture, and pattern.

b. Mount or display Samples in a manner to facilitate review of qualities indicated. Include the following:

1) Specification Section number and reference.
2) Generic description of the Sample.
3) Sample source.
4) Product name or name of the manufacturer.
5) Compliance with recognized standards.
6) Availability and delivery time.
7) Size limitations.
8) Compliance with governing regulations.

c. Submit Samples for review of size, kind, color, pattern, and texture. Submit Samples for a final check of these characteristics with other elements and a comparison of these characteristics between the final submittal and the actual component as delivered and installed.

1) Where variation in color, pattern, texture, or other characteristic is inherent in the material or product represented, submit at least three (3) multiple units that show approximate limits of the variations.
2) Refer to other Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, & details of assembly, connections, operation, and similar construction characteristics.

3) Refer to other Sections for Samples to be returned to the Contractor for incorporation in the work. Such Samples must be undamaged at time of use. On the transmittal, indicate special requests regarding disposition of Sample submittals.
4) Samples not incorporated into the work or otherwise designated as the University's property, are the property of the Contractor and shall be removed from the site prior to Substantial Completion.

d. Submittals: Submit three (3) sets. The A/E will retain one (1) set and send two (2) sets marked with the action taken to the University. The University will retain one (1) set and return the other set to the CM or Contractor.

e. Maintain sets of Samples, as returned, at the project Site, for quality comparisons throughout the course of construction.

1) Unless noncompliance with Contract Document provisions is observed, the submittal may serve as the final submittal.
2) Approved sample sets will be used by the A/E and the University to determine final acceptance of the construction associated with each set.

K. Quality Assurance Submittals

1. In addition to the general submittal procedures, the following requirements apply to quality assurance submittals:

a. Submit quality-control submittals, including design data, certifications, manufacturer's instructions, manufacturer's field reports, and other quality-control submittals as required under other Sections of the Specifications.

b. Certifications: Where other Sections of the Specifications require certification that a product, material, or installation complies with specified requirements, submit a notarized certification from the manufacturer certifying compliance with specified requirements.

c. Signature: Certification shall be signed by an officer of the manufacturer or other individual authorized to sign documents on behalf of the company.

d. Inspection and Test Reports: Requirements for submittal of inspection and test reports from independent testing agencies are specified in Division 1 Section "Quality Control."

L. Architect/Engineer’s (A/E) Action

1. The A/E will review each submittal, mark to indicate action taken, and transmit the submittals promptly to the UM OFM Project Manager.

a. Compliance with the contract documents is the Contractor's responsibility.

2. Submittal Action: The A/E will fill in the appropriate boxes on the UM Standard Project Submittal Form attached to each submittal and attach their comments as necessary. The University will fill in the lower portion of the form as necessary on each submittal to indicate the University has reviewed the submittals. The A/E's submittal stamp shall not be used on submittals for UM projects.

M. Construction Manager's (CM) or Contractor Action

1. The CM or Contractor shall be responsible for the collection of all project submittals from the suppliers and subcontractors for distribution to the A/E and the University for review. The CM is responsible for the redistribution of the reviewed submittals back to the subcontractors and suppliers for appropriate action based on the A/E and University review comments.
2. Submittal Action: The UM Standard Project Submittal Form will indicate how the CM or Contractor needs to proceed with each submittal as follows:

a. Action – "No Exceptions Taken": Submittals returned to the CM or Contractor as "No Exceptions Taken" indicates the submitted material and equipment appears to comply with requirements of the Contract Documents and therefore the work related to the submittal can proceed. Final payment depends on that compliance.

b. Action – "Note Markings/Attachments": Submittals returned to the CM or Contractor as "Note Markings/Attachments" indicates the submitted material and equipment will appear to comply with requirements of the Contract Documents provided the noted comments become a part of the submission and therefore the work related to the submittal can proceed. Final payment depends on that compliance.

c. Action – "Amend & Resubmit": Submittals returned to the CM or Contractor as "Amend & Resubmit" indicates some of the submitted material and equipment does not comply with the requirements of the Contract Documents and therefore the work related to the submittal cannot proceed until the re-submittal process confirms that the material and equipment complies with the requirements of the Contract Documents. Final payment depends on that compliance.

d. Action–"Rejected/Resubmit": Submittals returned to the CM or Contractor as "Rejected/Resubmit" indicates that there are significant and fundamental deficiencies indicated in the submitted material and equipment, and does not comply with the requirements of the Contract Documents. Therefore the work related to the submittal cannot proceed until the re-submittal process

confirms that the material and equipment complies with the requirements of the Contract Documents. Final payment depends on that compliance.

3. When the CM or Contractor receives submittals as “Amend & Resubmit” or “Rejected/Resubmit," the CM or Contractor shall not proceed with work covered by these submittals, including purchasing, fabrication, delivery, or other activity. Revise or prepare new submittals according to the notations; resubmit without delay. Repeat as necessary to obtain acceptance from the A/E and UM.

4. Do not use, or allow others to use, submittals marked “Amend & Resubmit" or “Rejected/Resubmit” at the Project Site or elsewhere where work is in progress.

5. Other Action: Where a submittal is for information or record purposes or special processing or other activity, the University will return the submittal marked "Action Not Required."

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 UM STANDARD PROJECT SUBMITTAL FORM

A. The electronic file for this form is available at the UM Architecture Engineering and Construction Documents web site.

UMB STANDARD PROJECT SUBMITTAL FORM

UMB PROJECT NAME: _____

UMB PROJECT NUMBER: _____ UM SYSTEM CAMPUS: _____

CONTRACTOR: Submission is in compliance with contract requirements, including dimensions, quantities and all trade coordination. ___Submitted as specified ___Substitution in accordance with ***Insert Spec Section Here*** Date: ___/___/___ By:_____	C M: Submittal No. _____ ***Insert Submittal # above*** ___Submission to the University and AE is in accordance with ***Contract Insert Contract No. Here*** ___ Disapproved Date: ___/___/___ By:_____
PROJECT ARCH: __ No Exceptions Taken __Note Markings/Attachments __Amend & Resubmit __Rejected/Resubmit Review of the submission by the Architect is in accordance with and governed by the Architect Agreement ***Insert Contact # here.*** For explanation of the Architect's review comments, refer to Section ***Insert Spec Section here*** of the Specifications. Date: ___/___/___ By:_____	ASSOCIATED ARCH: __ No Exceptions Taken __Note Markings/Attachments __Amend & Resubmit __Rejected/Resubmit Date: ___/___/___ By:_____
CIVIL ENGINEER: __ No Exceptions Taken __Note Markings/Attachments __Amend & Resubmit __Rejected/Resubmit Date: ___/___/___ By:_____	STRUCTURAL ENGINEER: __ No Exceptions Taken __Note Markings/Attachments __Amend & Resubmit __Rejected/Resubmit Date: ___/___/___ By:_____
MEP ENGINEER: __ No Exceptions Taken __Note Markings/Attachments __Amend & Resubmit __Rejected/Resubmit Date: ___/___/___ By:_____	CONSULTANT __No Exceptions Taken __Note Markings/Attachments __Amend & Resubmit __Rejected/Resubmit Date: ___/___/___ By:_____
OWNER: Date: ___/___/___ Regional Review By:_____ Date: ___/___/___ UMB Review By:_____ Owner Comments: _____ _____ _____ Review by Owner does not relieve the CM and/or AE of their obligations under the above noted contracts respectively.	

3.2 UM STANDARD PROJECT RFI FORM

A. The electronic file for this form is available at the UM Architecture Engineering and Construction Documents web site.

UMB STANDARD REQUEST FOR INFORMATION FORM

REQUEST FOR INFORMATION (RFI) No.:	**Date:**
Subject:	**UMB Project Title:**
Discipline:	**UMB Project No.:**
Specification Reference:	**Importance:**
Drawing Reference:	**Return RFI By:**

Information Requested:

Requested By:	**Date Requested:**

Contractors Proposed Solution:

Submitted By:	**Date Submitted:**

A/E Response:

Reviewed By:	**Date Reviewed:**

UMB Response:

Reviewed By:	**Date Reviewed:**

END OF SECTION 01300

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SECTION 01311 - SCHEDULES AND REPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for schedules, reports, and critical path method scheduling required for proper performance of the Work, including:

1. Submittal schedule.
2. Schedule of inspections and tests.
3. Daily construction reports.
4. Material location reports.
5. Field correction reports.
6. Special reports.

B. The contractor shall submit a CPM schedule that identifies the overall project construction phasing plan as well as phasing plans for each of the project areas as identified in the document packages A, B, and C sets.

1.3 SUBMITTAL PROCEDURES

A. Coordination: Coordinate preparation and processing of schedules and reports with performance of other construction activities.

1.4 DEFINITIONS

A. Critical Path Method (CPM): A method of planning and scheduling a construction project where activities are arranged based on activity relationships and network calculations determine when activities can be performed and the critical path of the Project.

B. Critical Path: The longest continuous chain of activities through the network schedule that establishes the minimum overall project duration.

C. Network Diagram: A graphic diagram of a network schedule, showing the activities and activity relationships.

D. 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 activities are activities on the critical path.
2. Predecessor activity is an activity that must be completed before a given activity can be started.

E. Event: An event is the starting or ending point of an activity.

F. Milestone: A key or critical point in time for reference or measurement.

G. Float is the measure of leeway in activity performance. Accumulative float time belongs to the University.

1. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the following activity.
2. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned project completion date.

1.5 QUALITY ASSURANCE

A. The Contractor's Consultant: Retain a consultant to provide planning, evaluating, and reporting by CPM scheduling.

B. The Consultant shall be a recognized specialist, acceptable to the University, who is an expert in CPM scheduling and reporting.

C. The Consultant shall have computer facilities that are capable of delivering detailed network diagrams within 48 hours of request.

D. In-House Option: The University may waive the requirement to retain a consultant if the Contractor can demonstrate that:

1. The Contractor has the computer equipment required to produce CPM network diagrams.
2. The Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques.

E. Program: Use a computer software program for network analysis that has been developed specifically to manage CPM construction schedules and is acceptable to the University.

F. Standards: Comply with procedures contained in AGC's "Construction Planning & Scheduling."

1.6 PRELIMINARY NETWORK DIAGRAM

A. Preliminary Network Diagram: Submit a preliminary network diagram within fourteen (14) days of the Notice to Proceed. The preliminary network diagram shall outline activities for the first sixty (60) days of construction. Include a skeleton diagram for the remainder of the Work with the preliminary diagram.

1. Include each significant construction activity. Coordinate each activity in the network with other activities. Schedule each construction activity in proper sequence.
2. Indicate completion of the Work on the date established for Substantial Completion, unless the University agrees otherwise.

B. Cash Requirement Prediction: With submittal of the preliminary network diagram, include a preliminary cash requirement prediction based on indicated activities.

C. Distribution: Distribute the preliminary network diagram to parties involved in construction activities that are scheduled early, including the University and the University.

1.7 CPM SCHEDULE

A. Prepare the Contractor's Construction Schedule using the network analysis diagram system known as the critical path method (CPM). Follow procedures outlined in AGC's "Construction Planning & Scheduling."

1. Proceed with preparation of the network diagram immediately following Notice to Proceed.
2. Follow the steps necessary to complete development of the network diagram in sufficient time to submit the CPM Schedule so it can be accepted for use no later than sixty (60) days after commencement of the Work.
3. Conduct educational workshops to train and inform key project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
4. Establish procedures for monitoring and updating the CPM Schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates. Use "one working day" as the unit of time.

B. The CPM schedule shall adhere to the following construction phasing requirements:
1. The Howard Hall new electric room expansion, chilled water pipe relocation, Howard Hall 15kV Switchgear installation, and Howard Hall 480V Switchgear installation can begin concurrently with the North Switching Station. However, power will not be available for the Howard Hall 15kV Switchgear (and 480V switchgear) until the feeders from the North Switching Station Switchgear is provided.

2. The work at the Peaking Plant can occur concurrently with the North Switching Station Switchgear installation.
3. The MSTF generators and standby automatic transfer switches cannot be removed until the switchgear and associated control system at Howard Hall and the North Switching Station are completed and accepted as operational by the Owner. In addition, the new 15 kV feeder spliced from manhole Ex EMH-9 shall be installed and connected to the main switchgear in MSTF prior to removal of the generators and standby automatic transfer switches.

C. CPM Schedule Preparation: Prepare a list of all activities involved in the Project. Include a list of activities required to complete the Work. No single activity shall exceed fifteen (15) work days. Provide the best data available for generation of the network diagram and the CPM Schedule.

1. Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities.
2. Indicate estimated times for the following activities to be performed:
   a. Preparation and processing of submittals.
   b. Purchase of materials.
   c. Delivery.
   d. Fabrication.
   e. Installation.
3. Treat each story or separate area as a separate numbered activity for principal elements of the Work.
4. Using the preliminary network diagram, prepare a skeleton network to identify probable critical paths.

D. Processing: Enter prepared data on the processing system. Process data to produce output data or 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 Contract Time.

E. Format: Display the full network on a single sheet of stable transparency, or other reproducible media, of sufficient width to show data clearly for the entire construction period.

1. Mark the critical path. Locate the critical path near the center of the network; locate paths with the most float near the edges.
2. Subnetworks on separate sheets are permissible for activities clearly off the critical path.

F. Initial Issue: Prepare the initial issue of the CPM Schedule network diagram from a listing of straight "early start-total float" sort. Identify critical activities. Prepare tabulated reports to show the following:

1. The Contractor or subcontractor and Work or activity.
2. Description of the activity.
3. Principal events of that activity.
4. Immediate preceding and succeeding activities.
5. Early and late start dates.
6. Early and late finish dates.
7. Activity duration in working days (maximum limit is fifteen (15) work days for construction activity).
8. Total float or slack time.
9. Average size of workforce.
10. Dollar value of activity (coordinated with the Schedule of Values).

G. Value Summaries: Prepare two (2) cumulative value listings, sorted by finish dates.

1. In first listing, tabulate the following:
   a. Activity number.
   b. Early finish date.
   c. Dollar value.
   d. Cumulative dollar value.
2. In second listing, tabulate the following:
   a. Activity number.
   b. Late finish date.
   c. Dollar value.
   d. Cumulative value.
3. In subsequent issues of both listings, substitute actual finish dates for activities completed as of listing date.
4. Prepare listing for ease of comparison with payment requests; coordinate timing with progress meetings.
   a. In both value summary listings, tabulate "actual percent complete," and "cumulative value completed" with total at bottom.
   b. Submit value summary printouts following each regularly scheduled progress meeting.

1.8 CPM SUBMITTALS

A. Submittal and Distribution: Submit three (3) copies of the initial issue of the tabulations and network to the University for acceptance. When authorized, distribute copies to the separate contractors, subcontractors and suppliers or fabricators, and others identified by the Contractor with a need-to-know schedule responsibility.

1. Post copies in the 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.

3. Submit copies of each computer-produced report to the University.

B. Schedule Updating: Revise the schedule immediately after each meeting or other activity, where revisions have been recognized or made. Issue the updated schedule at each project meeting and submit with application for payment. Requests for payment will not be made without an updated CPM schedule.

1.9 SUBMITTAL SCHEDULE

A. After development and acceptance of the Contractor's CPM Schedule, prepare a complete schedule of submittals. Submit the schedule within ten (10) days of the date required for submittal of the Contractor's CPM Schedule.

1. Coordinate Submittal Schedule with the list of subcontracts, Schedule of Values and the list of products as well as the Contractor's Construction Schedule.

B. Prepare the schedule in chronological order. Provide the following information:

1. Scheduled date for the first submittal.
2. Related Section number.
3. Submittal category.
4. Name of the subcontractor.
5. Description of the part of the Work covered.
6. Latest scheduled date for the University’s review/approval.

C. Distribution: Upon final approval of the University, print and distribute copies to the University, University, subcontractors, and other parties required to comply with submittal dates indicated.

1. Post copies in the Project meeting room and temporary field office.
2. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned part of the Work and are no longer involved in construction activities.

D. Schedule Updating: Revise the schedule after each meeting or other activity where revisions have been recognized or made. Issue the updated schedule concurrently with the report of each meeting.

1.10 SCHEDULE OF INSPECTIONS AND TESTS

A. Prepare a schedule of inspections, tests, and similar services required by the Contract Documents. Submit the schedule within thirty (30) days of the date established for commencement of the Work.

B. Form: The schedule shall be in tabular form and shall include, but not be limited to, the following:

1. Specification Section number.
2. Description of the test.
3. Identification of applicable standards.
4. Identification of test methods.
5. Number of tests required.
6. Time schedule or time span for tests.
7. Entity responsible for performing tests.
8. Requirements for taking samples.
9. Unique characteristics of each service.

C. Distribution: Distribute the schedule to the University, and each party involved in performance of portions of the Work where inspections and tests are required.

D. Schedule Updating: Revise the schedule after each meeting or other activity where revisions have been recognized or made. Issue the updated schedule concurrently with the report of each meeting.

1.11 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at the site. Submit duplicate copies to the University at weekly intervals:

1. List of subcontractors at the site.
2. List of separate contractors at the site.
3. Approximate count of personnel at the site.
4. High and low temperatures, general weather conditions.
5. Accidents.
6. Meetings and significant decisions.
7. Unusual events (refer to special reports).
8. Stoppages, delays, shortages, and losses.
9. Meter readings and similar recordings.
10. Emergency procedures.
11. Orders and requests of governing authorities.
12. Change Orders received, implemented.
13. Services connected, disconnected.
14. Equipment or system tests and startups.
15. Partial Completions, occupancies.
16. Substantial Completions authorized.

B. Material Location Reports: At weekly intervals, prepare a comprehensive list of materials delivered to and stored at the site. The list shall be cumulative, showing materials

previously reported plus items recently delivered. Include with the list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from the site. Submit copies of the list to the University at weekly intervals.

1.12 SPECIAL REPORTS

A. General: Submit special reports directly to the University within one day of an occurrence. Submit a copy to other parties affected by the occurrence.

B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at the site, prepare and submit a special report. List the chain of events, persons participating, response by the Contractor's personnel, an evaluation of the results or effects and similar pertinent information. Advise the University in advance when such events are anticipated or predictable.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01311

SECTION 01380 - CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for construction photographs for the following types of projects:

1. New construction projects.
2. Campus renovation projects.

1.3 CM REQUIREMENTS

A. The CM shall make arrangements to have a series of construction photographs taken of the construction site utilizing their personnel with a digital camera.

B. The CM shall maintain an up-to-date electronic file of the photographs in numerical order per month in an XL spread sheet format as follows:

1. The XL spread sheet shall include a header with the UM Project Name and Project Number. Under the header include columns for “Photo #”, “Date” “Location on Project Site”, “View of the Photo” “Description” and “Photograph”. For Example:

a. Photo #1
b. 6-5-12
c. Roof Level
d. Looking East
e. Roof Flashing at Stair Tower
f. Photograph

1.4 SUBMITTALS

A. Monthly: Submit construction photographs, electronically, in “pdf” file format to the University Project Manager (PM) monthly with the application for payment.

1. Organize the electronic “pdf” files as indicated in paragraph 1.3 above.
2. Pre-construction photographs shall be submitted with the first application for payment.

1.5 PHOTOGRAPHIC REQUIREMENTS

A. The CM shall take a series of construction photographs to document conditions at the project site and during various stages of construction as follows:

1. Pre-Construction Photographs: Prior to the start of construction take photographs of the project site and adjacent areas as follows:

a. New Projects: Take photographs in sufficient number to show existing conditions adjacent to the work areas before starting work. Where applicable, take photographs of existing buildings either on or adjoining the property in sufficient detail to record accurately the physical conditions at the start of construction.

b. Campus Renovation Projects: Take photographs in sufficient number to show existing conditions adjacent to the work areas, to indicate pre construction damage to existing walls, partitions, insulation, previous work that was not completed, and/or missing materials before starting work.

2. Construction Progress Photographs:

a. Take project photographs, in accordance with requirements indicated, to best show the status of construction and progress since taking previous photographs.

b. Frequency: Take photographs weekly.

c. Vantage Points: Comply with the University's directions concerning desired vantage points for shots.

3. Record Photograph Files:

a. At the end of the project submit a complete set of record photographs, organized in XL spread sheets on a CD-R in a full size jewel case to the University. Label the CD-R and the jewel case with the UM project, UM Project Number, contents on the CD, and the submission date.

4. Post Construction Photographs:

a. After the project has completed if the A/E, the CM, and/or other contractors would like to have a series of post construction photographs taken of the project site they must submit a written request to the University PM. The PM will contact the contact the appropriate University representatives to

gain approval and the set up a time for the photographs to be taken. Post construction photographs will not be allowed without the approval of the end usurer or their representative.

END OF SECTION 01380

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SECTION 01400 - QUALITY CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for quality-control services.

B. Quality-control services include inspections, tests, and related actions, including reports, performed by Contractor, by independent agencies, and by governing authorities. They do not include contract enforcement activities performed by the University.

C. Inspection and testing services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with Contract Document requirements.

1.3 RESPONSIBILITIES

A. Contractor Responsibilities: Unless otherwise indicated as the responsibility of another identified entity, Contractor shall provide inspections, tests, and other quality-control services specified elsewhere in the Contract Documents and required by authorities having jurisdiction. Costs for these services are included in the Contract Sum.

1. Where individual Sections specifically indicate that certain inspections, tests, and other quality-control services are the Contractor's responsibility, the Contractor may perform testing by its own workforce. Otherwise, and as indicated in individual Sections, the Contractor shall employ and pay a qualified independent testing agency to perform quality-control services. Costs for these services are included in the Contract Sum.
2. Where individual Sections specifically indicate that certain inspections, tests, and other quality-control services are the University's responsibility, the University will employ and pay a qualified independent testing agency to perform those services.

    a. Where the University has engaged a testing agency for testing and inspecting part of the Work, and the Contractor is also required to engage an entity for the same or related element, the Contractor shall not employ the entity engaged by the University, unless agreed to in writing by the University.

B. Retesting: The Contractor is responsible for retesting where results of inspections, tests, or other quality-control services prove unsatisfactory and indicate noncompliance with Contract Document requirements, regardless of whether the original test was Contractor's responsibility.

1. The cost of retesting construction, revised or replaced by the Contractor, is the Contractor's responsibility where required tests performed on original construction indicated noncompliance with Contract Document requirements.

C. Associated Services: Cooperate with agencies performing required inspections, tests, and similar services, and provide reasonable auxiliary services as requested. Notify the agency sufficiently in advance of operations to permit assignment of personnel. Auxiliary services required include, but are not limited to, the following:

1. Provide access to the Work.
2. Furnish incidental labor and facilities necessary to facilitate inspections and tests.
3. Take adequate quantities of representative samples of materials that require testing or assist the agency in taking samples.
4. Provide facilities for storage and curing of test samples.
5. Deliver samples to testing laboratories.
6. Provide the agency with a preliminary design mix proposed for use for materials mixes that require control by the testing agency.
7. Provide security and protection of samples and test equipment at the Project Site.

D. Duties of the Testing Agency: The independent agency engaged to perform inspections, sampling, and testing of materials and construction specified in individual Sections shall cooperate with the University and the Contractor in performance of the agency's duties. The testing agency shall provide qualified personnel to perform required inspections and tests.

1. The agency shall notify the University and the Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. The agency is not authorized to release, revoke, alter, or enlarge requirements of the Contract Documents or approve or accept any portion of the Work.
3. The agency shall not perform any duties of the Contractor.

E. Coordination: Coordinate the sequence of activities to accommodate required services with a minimum of delay. Coordinate activities to avoid the necessity of removing and replacing construction to accommodate inspections and tests.

1. The Contractor is responsible for scheduling times for inspections, tests, taking samples, and similar activities.

1.4 SUBMITTALS

A. Unless the Contractor is responsible for this service, the independent testing agency shall submit a certified written report, in duplicate, of each inspection, test, or similar service to the University. If the Contractor is responsible for the service, submit a certified written report, in duplicate, of each inspection, test, or similar service through the Contractor.

1. Submit additional copies of each written report directly to the governing authority, when the authority so directs.
2. Report Data: Written reports of each inspection, test, or similar service include, but are not limited to, the following:
   a. Date of issue of report.
   b. Project title and number.
   c. Name, address, and telephone number of testing agency.
   d. Dates and locations of samples and tests or inspections.
   e. Names of individuals making the inspection or test.
   f. Designation of the Work and test method.
   g. Identification of product and Specification Section.
   h. Complete inspection or test data.
   i. Test results and an interpretation of test results.
   j. Ambient conditions at the time of sample taking and testing.
   k. Comments or professional opinion on whether inspected or tested Work complies with Contract Document requirements.
   l. Name and signature of laboratory inspector.
   m. Recommendations on retesting.

1.5 QUALITY ASSURANCE

A. Qualifications for Service Agencies: Engage inspection and testing service agencies, including independent testing laboratories, that are prequalified as complying with the American Council of Independent Laboratories' "Recommended Requirements for Independent Laboratory Qualification" and that specialize in the types of inspections and tests to be performed.

1. Each independent inspection and testing agency engaged on the Project shall be authorized by authorities having jurisdiction to operate in the state where the Project is located.

PART 2 - EXECUTION

3.1 REPAIR AND PROTECTION

A. General: Upon completion of inspection, testing, sample taking and similar services, repair damaged construction and restore substrates and finishes. Comply with Contract Document requirements for Division 1 Section "Cutting and Patching."

B. Protect construction exposed by or for quality-control service activities, and protect repaired construction.

C. Repair and protection is Contractor's responsibility, regardless of the assignment of responsibility for inspection, testing, or similar services.

END OF SECTION 01400

SECTION 01500 - CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes requirements for construction facilities and temporary controls, including temporary utilities, support facilities, and security and protection.

Temporary utilities include, but are not limited to, the following:

1. Water service and distribution.
2. Temporary electric power and light.
3. Temporary heat.
4. Ventilation.
5. Telephone service.
6. Sanitary facilities, including drinking water.
7. Storm and sanitary sewer.

Support facilities include, but are not limited to, the following:

1. Field offices and storage sheds.
2. Dewatering facilities and drains.
3. Temporary enclosures.
4. Hoists and temporary elevator use.
5. Temporary project identification signs and bulletin boards.
6. Waste disposal services.
7. Rodent and pest control.
8. Construction aids and miscellaneous services and facilities.

Security and protection facilities include, but are not limited to, the following:

1. Barricades, warning signs, and lights.
2. Sidewalk bridge or enclosure fence for the site.
3. Environmental protection.

1.3 SUBMITTALS

A. Temporary Utilities: Submit reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.

B. Implementation and Termination Schedule: Within 15 days of the date established for commencement of the Work, submit a schedule indicating implementation and termination of each temporary utility.

1.4 QUALITY ASSURANCE

A. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction including, but not limited to, the following:

1. Building code requirements.
2. Health and safety regulations.
3. Utility company regulations.
4. Police, fire department, and rescue squad rules.
5. Environmental protection regulations.

B. Standards: Comply with NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations," ANSI A10 Series standards for "Safety Requirements for Construction and Demolition," and NECA Electrical Design Library "Temporary Electrical Facilities."

1. Electrical Service: Comply with NEMA, NECA, and UL standards and regulations for temporary electric service. Install service in compliance with NFPA 70 "National Electric Code."

C. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.

1.5 PROJECT CONDITIONS

A. Temporary Utilities: Prepare a schedule indicating dates for implementation and termination of each temporary utility. At the earliest feasible time, when acceptable to the University, change over from use of temporary service to use of permanent service.

B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Relocate temporary services and facilities as the Work progresses. Do not overload facilities or permit them to interfere with progress. Take necessary fire-prevention measures. Do not allow hazardous, dangerous, or unsanitary conditions, or public nuisances to develop or persist on-site.

PART 2 - PRODUCTS

2.1 MATERIALS

General: Provide new materials. If acceptable to the University, the Contractor may use undamaged, previously used materials in serviceable condition. Provide materials suitable for use intended.

A. Lumber and Plywood:
   1. For signs and directory boards, provide exterior-type, Grade B-B high-density concrete form overlay plywood of sizes and thicknesses indicated.
   2. For fences and vision barriers, provide minimum 3/8-inch- (9.5-mm-) thick exterior plywood.
   3. For safety barriers, sidewalk bridges, and similar uses, provide minimum 5/8-inch- (16-mm-) thick exterior plywood.

B. Paint:
   1. For sign panels and applying graphics, provide exterior-grade alkyd gloss enamel over exterior primer.

C. Tarpaulins: Provide waterproof, fire-resistant, UL-labeled tarpaulins with flame-spread rating of fifteen (15) or less. For temporary enclosures, provide translucent, nylon-reinforced, laminated polyethylene or polyvinyl chloride, fire-retardant tarpaulins.

D. Water: Provide potable water approved by local health authorities.

E. Open-Mesh Fencing: Provide 0.120-inch- (3-mm-) thick, galvanized 2 inch (50-mm) chain link fabric fencing six (6) feet (2 m) high with galvanized barbed-wire top strand and galvanized steel pipe posts, 1-1/2 inches (38 mm) I.D. for line posts and 2-1/2 inches (64 mm) I.D. for corner posts.

2.2 EQUIPMENT

A. General: Provide new equipment. If acceptable to the University, the Contractor may use undamaged, previously used equipment in serviceable condition. Provide equipment suitable for use intended.

B. Water Hoses: Provide 3/4-inch (19-mm), heavy-duty, abrasion-resistant, flexible rubber hoses one hundred (100) feet (30 m) long, with pressure rating greater than the maximum pressure of the water distribution system. Provide adjustable shutoff nozzles at hose discharge.

C. Electrical Outlets: Provide properly configured, NEMA-polarized outlets to prevent insertion of 110- to 120-Volt plugs into higher voltage outlets. Provide receptacle outlets equipped with ground-fault circuit interrupters, reset button, and pilot light for connection of power tools and equipment.

D. Electrical Power Cords: Provide grounded extension cords. Use hard-service cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths

of electric cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.

E. Lamps and Light Fixtures: Provide general service incandescent lamps of wattage required for adequate illumination. Provide guard cages or tempered-glass enclosures where exposed to breakage. Provide exterior fixtures where exposed to moisture.

F. Heating Units: Provide temporary heating units that have been tested and labeled by UL, FM, or another recognized trade association related to the type of fuel being consumed.

G. Temporary Offices: Provide prefabricated or mobile units or similar job-built construction with lockable entrances, operable windows, and serviceable finishes. Provide heated and air-conditioned units on foundations adequate for normal loading.

H. Temporary Toilet Units: Provide self-contained, single-occupant toilet units of the chemical, aerated recirculation, or combustion type. Provide units properly vented and fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.

I. Fire Extinguishers: Provide hand-carried, portable, UL-rated, Class A fire extinguishers for temporary offices and similar spaces. In other locations, provide hand-carried, portable, UL-rated, Class ABC, dry-chemical extinguishers or a combination of extinguishers of NFPA-recommended classes for the exposures.

1. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Use qualified personnel for installation of temporary facilities. Locate facilities where they will serve the Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required.

B. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

A. General: Coordinate with the University Operations and Maintenance Personnel to install temporary service or connect to existing service. Provide all necessary labor, materials and equipment for connections.

1. Coordinate with the University for a time when service can be interrupted, if necessary, to make connections for temporary services.
2. Provide adequate capacity at each stage of construction. Prior to temporary utility availability, provide trucked-in services.
3. Obtain easements to bring temporary utilities to the site where the University's easements cannot be used for that purpose.
4. Use Charges: Cost or use charges for temporary facilities are not chargeable to the University. The University will not accept cost or use charges as a basis of claims for Change Orders.

B. Water Service: Install water service and distribution piping of sizes and pressures adequate for construction until permanent water service is in use.

1. Sterilization: Sterilize temporary water piping prior to use.

C. Temporary Electric Power Service: Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period. Include meters, transformers, overload-protected disconnects, automatic ground-fault interrupters, and main distribution switch gear.

1. Install electric power service underground, except where overhead service must be used.
2. Power Distribution System: Install wiring overhead and rise vertically where least exposed to damage. Where permitted, wiring circuits not exceeding 125 Volts, ac 20 Ampere rating, and lighting circuits may be nonmetallic sheathed cable where overhead and exposed for surveillance.

D. Temporary Lighting: When overhead floor or roof deck has been installed, provide temporary lighting with local switching.

1. Install and operate temporary lighting that will fulfill security and protection requirements without operating the entire system. Provide temporary lighting that will provide adequate illumination for construction operations and traffic conditions.

E. Temporary Heat: Provide temporary heat required by construction activities for curing or drying of completed installations or for protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce the ambient condition required and minimize consumption of energy.

F. Heating Facilities: Except where the University authorizes use of the permanent system, provide vented, self-contained, LP-gas or fuel-oil heaters with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open flame, or salamander heating units is prohibited.

G. Temporary Telephones: Provide temporary telephone service throughout the construction period for all personnel engaged in construction activities. Install telephone on a separate line for each temporary office and first-aid station.

1. Separate Telephone Lines: Provide additional telephone lines for the following:
   a. Where an office has more than two (2) occupants, install a telephone for each additional occupant or pair of occupants.
   b. Provide a dedicated telephone line for a fax machine in the field office.
   c. Provide a separate line for the University's use.
2. At each telephone, post a list of important telephone numbers.

H. Sanitary facilities include temporary toilets, wash facilities, and drinking-water fixtures. Comply with regulations and health codes for the type, number, location, operation, and maintenance of fixtures and facilities. Install where facilities will best serve the Project's needs.

1. Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Provide covered waste containers for used material.

I. Toilets: Install self-contained toilet units. Shield toilets to ensure privacy. Use of pit-type privies will not be permitted.

1. Provide separate facilities for male and female personnel.

J. Sewers and Drainage: Provide temporary connections to remove effluent that can be discharged lawfully. If drainage facilities cannot be lawfully used for discharge of effluent, provide containers to remove and dispose of effluent off-site in a lawful manner.

1. Filter out excessive amounts of soil, construction debris, chemicals, oils, and similar contaminants that might clog sewers or pollute waterways before discharge.
2. Connect temporary sewers to the municipal system, as directed by Baltimore City sewer department officials.
3. Maintain temporary sewers and drainage facilities in a clean, sanitary condition. Following heavy use, restore normal conditions promptly.

K. Provide earthen embankments and similar barriers in and around excavations and subgrade construction, sufficient to prevent flooding by runoff of storm water from heavy rains.

3.3 SUPPORT FACILITIES INSTALLATION

A. Locate field offices, storage sheds, and other temporary construction and support facilities for easy access.

1. Maintain support facilities until near Substantial Completion. Remove prior to Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to the University.

B. Field Offices: Provide insulated, weather tight temporary offices of sufficient size to accommodate required office personnel at the Project Site. Keep the office clean and orderly for use for small progress meetings. Furnish and equip offices as follows:

1. Furnish with a desk and chairs, a four (4) drawer file cabinet, plan table, plan rack, and a six (6) shelf bookcase.
2. Equip with a water cooler and include a table and chairs for progress meetings, private toilet complete with water closet, lavatory, and medicine cabinet unit with a mirror.

C. Storage and Fabrication Trailers: Install storage and fabrication trailers sized, furnished, and equipped to accommodate materials and equipment involved, including temporary utility service.

D. Dewatering Facilities and Drains: For temporary drainage and dewatering facilities and operations not directly associated with construction activities included under individual Sections, comply with dewatering requirements of applicable Division 2 Sections. Where feasible, utilize the same facilities. Maintain the site, excavations, and construction free of water.

E. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities.

1. Where heat is needed and the permanent building enclosure is not complete, provide temporary enclosures where there is no other provision for containment of heat. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.
2. Install tarpaulins securely, with incombustible wood framing and other materials. Close openings of twenty five (25) sq. ft. (2.3 sq. m) or less with plywood or similar materials.
3. Close openings through floor or roof decks and horizontal surfaces with load-bearing, wood-framed construction.

F. Project Identification and Temporary Signs: Prepare project identification and other signs of size indicated. Install signs where indicated to inform the public and persons seeking entrance to the Project. Support on posts or framing of preservative-treated wood or steel. Do not permit installation of unauthorized signs.

1. Project Identification Signs: Engage an experienced sign painter to apply graphics. Comply with details indicated.
2. Temporary Signs: Prepare signs to provide directional information to construction personnel and visitors.

G. Temporary Exterior Lighting: Install exterior yard and sign lights so signs are visible when Work is being performed.

H. Collection and Disposal of Waste: Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than seven (7) days during normal weather or three (3) days when the temperature is expected to rise above 80°F (27°C). Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material lawfully.

I. Rodent and Pest Control: Before deep foundation work has been completed, retain a local exterminator or pest control company to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests. Employ this service to perform extermination and control procedures at regular intervals so the Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using environmentally safe materials.

J. Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate. Cover finished, permanent stairs with a protective covering of plywood or similar material so finishes will be undamaged at the time of acceptance.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Except for use of permanent fire protection as soon as available, do not change over from use of temporary security and protection facilities to permanent facilities until Substantial Completion, or longer, as requested by the University.

B. Temporary Fire Protection: Until fire-protection needs are supplied by permanent facilities, install and maintain temporary fire-protection facilities of the types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 10 "Standard for Portable Fire Extinguishers" and NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations."

1. Locate fire extinguishers where convenient and effective for their intended purpose, but not less than one extinguisher on each floor at or near each usable stairwell. Store combustible materials in containers in fire-safe locations.
2. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire-protection facilities, stairways, and other access routes for fighting fires. Smoking is not permitted anywhere on project sites.

3. Provide supervision of welding operations, combustion-type temporary heating units, and similar sources of fire ignition.

C. Permanent Fire Protection: At the earliest feasible date in each area of the Project, complete installation of the permanent fire-protection facility, including connected services, and place into operation and use. Instruct key personnel on use of facilities.

D. Barricades, Warning Signs, and Lights: Comply with standards and code requirements for erection of structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and the public of the hazard being protected against. Where appropriate and needed, provide lighting, including flashing red or amber lights.

E. Enclosure Fence: Before excavation begins, install an enclosure fence with lockable entrance gates. Locate where indicated, or enclose the entire site or the portion determined sufficient to accommodate construction operations. Install in a manner that will prevent people, dogs, and other animals from easily entering the site, except by the entrance gates.

1. Provide open-mesh, chainlink fencing with posts set in a compacted mixture of gravel and earth.

F. Security Enclosure and Lockup: Install substantial temporary enclosure of partially completed areas of construction. Provide locking entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.

1. Storage: Where materials and equipment must be stored, and are of value or attractive for theft, provide a secure lockup. Enforce discipline in connection with the installation and release of material to minimize the opportunity for theft and vandalism.

G. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways, and subsoil might be contaminated or polluted or that other undesirable effects might result. Avoid use of tools and equipment that produce harmful noise. Restrict use of noise-making tools and equipment to hours that will minimize complaints from persons or firms near the site.

3.5 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. Limit availability of temporary facilities to essential and intended uses to minimize waste and abuse.

B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage by freezing temperatures and similar elements.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a twenty four (24) hour basis where required to achieve indicated results and to avoid possibility of damage.
2. Protection: Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.

C. Termination and Removal: Unless the University requests that it be maintained longer, remove each temporary facility when the need has ended, when 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 the 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 the Contractor's property. The University reserves the right to take possession of project identification signs.
2. At Substantial Completion, clean and renovate permanent facilities used during the construction period including, but not limited to, the following:
   a. Replace air filters and clean inside of ductwork and housings.
   b. Replace significantly worn parts and parts subject to unusual operating conditions.
   c. Replace lamps burned out or noticeably dimmed by hours of use.

END OF SECTION 01500

SECTION 01600 - MATERIALS AND EQUIPMENT, DELIVERY, STORAGE, AND HANDLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements governing the Contractor's selection of products for use in the Project.

1.3 DEFINITIONS

A. Definitions used in this Article are not intended to change the meaning of other terms used in the Contract Documents, such as "specialties," "systems," "structure," "finishes," "accessories," and similar terms. Such terms are self-explanatory and have well-recognized meanings in the construction industry.

1. "Products" are items purchased for incorporation in the Work, whether purchased for the Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
    a. "Named Products" are items identified by the manufacturer's product name, including make or model number or other designation, shown or listed in the manufacturer's published product literature, that is current as of the date of the Contract Documents.
    b. "Foreign Products," as distinguished from "domestic products," are items substantially manufactured (50 percent or more of value) outside the United States and its possessions. Products produced or supplied by entities substantially owned (more than 50 percent) by persons who are not citizens of, nor living within, the United States and its possessions are also considered to be foreign products.
2. "Materials" are products substantially shaped, cut, worked, mixed, finished, refined or otherwise fabricated, processed, or installed to form a part of the Work.
3. "Equipment" is a product with operational parts, whether motorized or manually operated, that requires service connections, such as wiring or piping.

1.4 SUBMITTALS:

A. All submittals shall comply with the requirements in the “SUBMITTALS” section.

1.5 QUALITY ASSURANCE

A. Source Limitations: To the fullest extent possible, provide products of the same kind from a single source.

   1. When specified products are available only from sources that do not, or cannot, produce a quantity adequate to complete project requirements in a timely manner, consult with the University to determine the most important product qualities before proceeding. Qualities may include attributes, such as visual appearance, strength, durability, or compatibility. When a determination has been made, select products from sources producing products that possess these qualities, to the fullest extent possible.

B. Compatibility of Options: When the Contractor is given the option of selecting between 2 or more products for use on the Project, the product selected shall be compatible with products previously selected, even if previously selected products were also options.
C. Foreign Product Limitations: Except under one or more of the following conditions, rovide domestic products, not foreign products, for inclusion in the Work:

   1. No available domestic product complies with the Contract Documents.
   2. Domestic products that comply with the Contract Documents are available only at prices or terms substantially higher than foreign products that comply with the Contract Documents.

D. Nameplates: Except for required labels and operating data, do not attach or imprint manufacturer's or producer's nameplates or trademarks on exposed surfaces of products that will be exposed to view in occupied spaces or on the exterior.

   1. Labels: Locate required product labels and stamps on concealed surfaces or, where required for observation after installation, on accessible surfaces that are not conspicuous.
   2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on an easily accessible surface that is inconspicuous in occupied spaces. The nameplate shall contain the following information and other essential operating data:
      a. Name of product and manufacturer.
      b. Model and serial number.
      c. Capacity.
      d. Speed.
      e. Ratings.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products according to the manufacturer's recommendations, using means and methods that will prevent damage, deterioration, and loss, including theft.

1. Schedule delivery to minimize long-term storage at the site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to assure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to the site in an undamaged condition in the manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products upon delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
5. Store products at the site in a manner that will facilitate inspection and measurement of quantity or counting of units.
6. Store heavy materials away from the Project structure in a manner that will not endanger the supporting construction.
7. Store products subject to damage by the elements above ground, under cover in a weather tight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instructions.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION

A. General Product Requirements: Provide products that comply with Contract Documents that are undamaged and new at time of installation.

1. Provide products complete with accessories, trim, finish, safety guards, and other devices and details needed for complete installation and intended use and effect.
2. Standard Products: Where available, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Where products are accompanied by the term as selected, University will make selection.
4. Where products are accompanied by the term match sample, sample to be matched is University's.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.

A. General Compliance Requirements: Compliance requirements for individual products, as indicated in Contract Documents, are multiple in nature and may include generic descriptions, performance requirements, compliance with reference standards, conformance with graphic details and other similar forms and methods of indicating requirements, all of which must be complied with.

B. Procedures for Selecting Products: Contractor's options for selecting products are limited by Contract Document requirements, and are not controlled by industry traditions or procedures experienced by Contractor on previous construction projects.

C. Products specified by Reference Standards, Codes and Regulations: Select from among products which can be shown to comply to referenced documents.

D. Products specified by Naming Products and Manufacturers: Select from among products listed.

E. Products specified by Naming One Manufacturer's Product as the Basis-of-Design with Reference to Other Manufacturers: Select either the specified Basis-of-Design product or an approved comparable product by one of the other named manufacturers.

1. Comply with provisions in Comparable Products Article to obtain approval for use of a comparable product by one of the named manufacturers.

F. Products specified by Naming One Manufacturer's Product and Indicating Option of Selecting Comparable Products by stating or Approved Equivalent or similar language: Select either the specified product or an approved comparable product.

1. Comply with provisions in Comparable Products Article to obtain approval for use of an unnamed comparable product by another manufacturer.

G. Visual Matching Specification: Where Specifications require matching an established Sample, select a product that complies with requirements and matches University's sample. University's decision will be final on whether proposed product matches satisfactorily.

H. Visual Selection Specification: Where Specifications include the phrase as selected from manufacturer's standard colors, patterns, textures or similar phrase, select a product that complies with other specified requirements. University will select color, pattern, and texture.

1. Standard Range: Where Specifications include the phrase standard range of colors, patterns, textures or similar phrase, University will select color, pattern, or texture from manufacturer's product line that does not include premium items.
2. Full Range: Where Specifications include the phrase full range of colors, patterns, textures or similar phrase, University will select color, pattern, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

A. Where Basis-of-Design products are specified by name, submit the following, in addition to other required submittals, to obtain approval of a comparable product by one of the named manufacturers:

1. Evidence that the proposed product does not require extensive revisions to the Contract Documents that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
2. Detailed comparison of significant qualities of proposed product with the Basis-of-Design product in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, serviceability, visual effect, and specific features and requirements indicated.
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 Universities, if requested.
5. Samples, if requested.

PART 3 - EXECUTION

3.1 INSTALLATION OF PRODUCTS

A. Comply with manufacturer's instructions and recommendations for installation of products in the applications indicated. Anchor each product securely in place, accurately located and aligned with other Work.

1. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

B. Install products in accordance with the execution’s sections of the Project Manual.

END OF SECTION 01600

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SECTION 01631 - SUBSTITUTIONS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for handling requests for substitutions made after award of the Contract.

B. Contractor's submittal and University's acceptance of Shop Drawings, Product Data, or Samples not complying with Contract Documents do not constitute an acceptable or valid request for substitution, nor do they constitute approval. Substitutions not properly authorized may be considered defective.

1.3 DEFINITIONS

A. Definitions in this Article do not change or modify the meaning of other terms used in the Contract Documents.

B. Substitutions: Changes in products, materials, equipment, and methods of construction required by the Contract Documents proposed by the Contractor after award of the Contract are considered to be requests for substitutions. The following are not considered to be requests for substitutions:

1. Substitutions requested during the bidding period, and accepted by Addendum prior to award of the Contract, are included in the Contract Documents and are not subject to requirements specified in this Section for substitutions.
2. Revisions to the Contract Documents requested by the University or University.
3. Specified options of products and construction methods included in the Contract Documents.
4. The Contractor's determination of and compliance with governing regulations and orders issued by governing authorities.

1.4 SUBMITTALS

A. Substitution Request Submittal: The University will consider requests for substitution if received within sixty (60) days after issuance of Notice to Proceed. Requests received more than sixty (60) days after issuance of Notice to Proceed may be considered or rejected at the discretion of the University.

1. Submit three (3) copies of each request for substitution for consideration. Submit requests in the form and according to procedures required for change-order proposals.
2. Identify the product or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers.
3. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
    a. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the University and separate contractors, that will be necessary to accommodate the proposed substitution.
    b. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements, such as performance, weight, size, durability, and visual effect.
    c. Product Data, including Drawings and descriptions of products and fabrication and installation procedures.
    d. Samples, where applicable or requested.
    e. A statement indicating the substitution's effect on the Contractor's CPM Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
    f. Cost information, including a proposal of the net change, if any in the Contract Sum.
    g. The Contractor's certification that the proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
    h. The Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.
    i. Confirmation that the same warranty will be furnished for substitute product as for specified product.

1.5 UNIVERSITY'S ACTION

A. University will review and take appropriate action upon Contractor's request for substitutions.

1. University's action will be taken with reasonable promptness, while allowing sufficient time in University's professional judgement to permit adequate review.
2. University shall be entitled to rely upon adequacy, accuracy, and completeness of data, and certifications prepared by Contractor.
3. If necessary, University will request additional information or documentation for evaluation after initial review of receipt of request for substitution.

PART 2 – PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01631

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for contract closeout including, but not limited to, the following:

1. Inspection procedures.
2. Project record document submittal, including the following:
3. Marked-up copies of Contract Drawings.
4. Marked-up copies of Shop Drawings.
5. Newly prepared drawings.
6. Marked-up copies of Specifications, addenda, and Change Orders.
7. Marked-up Product Data submittals.
8. Record Samples.
9. Field records for variable and concealed conditions.
10. Record information on Work that is recorded only schematically.
11. Operation and maintenance manual submittal.
12. Preparing and submitting operation and maintenance manuals for building operating systems and equipment.
13. Preparing and submitting instruction manuals covering the care, preservation, and maintenance of University products and finishes.
14. Instruction of the University's operating personnel in the operation and maintenance of building systems and equipment.
15. Submittal of warranties.
16. Final cleaning.

B. Closeout requirements for specific construction activities are included in the appropriate Sections the specifications.

C. Environmental Requirements: Conduct cleaning and waste-disposal operations in compliance with local laws and ordinances. Comply fully with federal and local environmental and antipollution regulations.

1. Do not dispose of volatile wastes, such as mineral spirits, oil, or paint thinner, in storm or sanitary drains.
2. Burning or burying of debris, rubbish, or other waste material on the premises is not permitted.

D. Maintenance of Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition. Make documents and Samples available at all times for the University's inspections.

E. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products. Manufacturer's disclaimers and limitations on product warranties do not relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

1.3 DEFINITIONS

A. Standard product warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the University.

B. Special warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the University.

1.4 WARRANTY REQUIREMENTS

A. Related Damages and Losses: When correcting failed or damaged warranted construction, remove and replace construction that has been damaged as a result of such failure or must be removed and replaced to provide access for correction of warranted construction.

B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of the Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the University has benefited from use of the Work through a portion of its anticipated useful service life.

D. University's Recourse: Expressed warranties made to the University are in addition to implied warranties and shall not limit the duties, obligations, rights, and remedies otherwise available under the law. Expressed warranty periods shall not be interpreted as limitations on the time in which the University can enforce such other duties, obligations, rights, or remedies.

1. Rejection of Warranties: The University reserves the right to reject warranties and to limit selection to products with warranties not in conflict with requirements of the Contract Documents.

E. Where the Contract Documents require a special warranty, or similar commitment on the Work or part of the Work, the University reserves the right to refuse to accept the Work, until the Contractor presents evidence that entities required to countersign such commitments are willing to do so.

1.5 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Before requesting inspection for certification of Substantial Completion, complete the following. List exceptions in the request.

1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100 percent completion for the portion of the Work claimed as substantially complete.
   a. Include supporting documentation for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Sum.
   b. If 100 percent completion cannot be shown, include a list of incomplete items, the value of incomplete construction, and reasons the Work is not complete.
2. Advise the University of pending insurance changeover requirements.
3. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications, and similar documents.
4. Obtain and submit releases enabling the University unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
5. Submit record drawings, maintenance manuals, final project photographs, damage or settlement surveys, property surveys, and similar final record information.
6. Deliver tools, spare parts, extra stock, and similar items, including inventory list.
7. Make final changeover of permanent locks and transmit keys to the University. Advise the University's personnel of changeover in security provisions.
8. Complete startup testing of systems and instruction of the University's operation and maintenance personnel. Discontinue and remove temporary facilities from the site, along with mockups, construction tools, and similar elements.
9. Complete final cleanup requirements, including touchup painting.
10. Touch up and otherwise repair and restore marred, exposed finishes.

B. Inspection Procedures: On receipt of a request for inspection, the University will either proceed with inspection or advise the Contractor of unfilled requirements. The University will prepare the Certificate of Substantial Completion following inspection or advise the Contractor of construction that must be completed or corrected before the certificate will be issued.

1. The University will repeat inspection when requested and assured that the Work is substantially complete.

2. Results of the completed inspection will form the basis of requirements for final acceptance.

1.6 FINAL ACCEPTANCE

A. Preliminary Procedures: Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.

1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include insurance certificates for products and completed operations where required.
2. Submit an updated final statement, accounting for final additional changes to the Contract Sum.
3. Submit a certified copy of the University's final punch list of items to be completed or corrected, endorsed and dated by the University. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance and will be endorsed and dated by the University.
4. Submit final meter readings for utilities, a measured record of stored fuel, and similar data as of the date of Substantial Completion or when the University took possession of and assumed responsibility for corresponding elements of the Work.
5. Submit consent of surety to final payment.
6. Submit a final liquidated damages settlement statement.
7. Submit evidence of final, continuing insurance coverage complying with insurance requirements.

B. Reinspection Procedure: The University will reinspect the Work upon receipt of notice that the Work, including inspection list items from earlier inspections, has been completed, except for items whose completion is delayed under circumstances acceptable to the University.

1. Upon completion of reinspection, the University will prepare a certificate of final acceptance. If the Work is incomplete, the University will advise the Contractor of Work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.

2. If necessary, reinspection will be repeated.

1.7 QUALITY ASSURANCE

A. Maintenance Manual Preparation: In preparation of maintenance manuals, use personnel thoroughly trained and experienced in operation and maintenance of equipment or system involved.

1. Where maintenance manuals require written instructions, use personnel skilled in technical writing where necessary for communication of essential data.
2. Where maintenance manuals require drawings or diagrams, use draftsmen capable of preparing drawings clearly in an understandable format.

B. Instructions for the University's Personnel: Use experienced instructors thoroughly trained and experienced in operation and maintenance of equipment or system involved to instruct the University's operation and maintenance personnel.

1.8 RECORD DOCUMENT SUBMITTALS

A. General: Do not use record documents for construction purposes. Protect record documents from deterioration and loss in a secure, fire-resistant location. Provide access to record documents for the University's reference during normal working hours.

B. Record Drawings (As-Builts):

1. Markup Procedure: During construction, maintain a set of blue- or black-line white prints of Contract Drawings and Shop Drawings for Project Record Document (As-Built) purposes.
   a. Mark these Drawings to show the actual installation where the installation varies from the installation shown originally. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later. Items required to be marked include, but are not limited to, the following:
      1) Dimensional changes to the Drawings.
      2) Revisions to details shown on the Drawings.
      3) Depths of foundations below the first floor.
      4) Locations and depths of underground utilities.
      5) Revisions to routing of piping and conduits.
      6) Revisions to electrical circuitry.
      7) Actual equipment locations.
      8) Duct size and routing.
      9) Locations of concealed internal utilities.
      10) Changes made by change order.
      11) Changes made following the University's written orders.
      12) Details not on original Contract Drawings.
   b. Mark record prints of Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and

accurately. Where Shop Drawings are marked, show cross-reference on Contract Drawings location.

c. Mark record sets with red erasable colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.

d. Mark important additional information that was either shown schematically or omitted from original Drawings.

e. Note change-order numbers, and similar identification.

2. Responsibility for Markup: The individual or entity who obtained record data, whether the individual or entity is the Installer, subcontractor, or similar entity, shall prepare the markup on record drawings.

a. Accurately record information in an understandable drawing technique.

b. Record data as soon as possible after obtaining it. Record and check the markup prior to enclosing concealed installations.

c. At time of Substantial Completion, submit record drawings to the University for the University's records. Organize into sets and bind and label sets for the University's continued use.

C. Record Specifications

1. During the construction period, maintain one copy of the Project Specifications, including addenda and modifications issued, for Project Record Document purposes.

a. Mark the Specifications to indicate the actual installation where the installation varies from that indicated in Specifications and modifications issued. Note related project record drawing information, where applicable. Give particular attention to substitutions, selection of product options, and information on concealed installations that would be difficult to identify or measure and record later.

1) In each Specification Section where products, materials, or units of equipment are specified or scheduled, mark the copy with the proprietary name and model number of the product furnished.

2) Record the name of the manufacturer, supplier, installer, and other information necessary to provide a record of selections made and to document coordination with record Product Data submittals and maintenance manuals.

3) Note related record Product Data, where applicable. For each principal product specified, indicate whether record Product Data has been submitted in maintenance manual instead of submitted as record Product Data.

b. Upon completion of markup, submit record Specifications to the University.

D. Record Product Data: Maintain one copy of each Product Data submittal. Note related Change Orders and markup of record drawings and Specifications.

1. Mark these documents to show significant variations in actual Work performed in comparison with information submitted. Include variations in products delivered to the site and from the manufacturer's installation instructions and recommendations.

2. Give particular attention to concealed products and portions of the Work that cannot otherwise be readily discerned later by direct observation.
3. Upon completion of markup, submit three complete sets of record Product Data to the University for the University's records.

E. Record Sample Submitted: Immediately prior to Substantial Completion, the Contractor shall meet with the University and the University's personnel at the Project Site to determine which Samples are to be transmitted to the University for record purposes. Comply with the University's instructions regarding delivery to the University's Sample storage area. Dispose of other samples in a manner specified for disposing surplus and waste materials.

F. Miscellaneous Record Submittals:

1. Refer to other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Immediately prior to Substantial Completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for use and reference. Submit to the University for the University's records.
   a. Categories of requirements resulting in miscellaneous records include, but are not limited to, the following:
      1) Field records on excavations and foundations.
      2) Field records on underground construction and similar work.
      3) Survey showing locations and elevations of underground lines.
      4) Invert elevations of drainage piping.
      5) Surveys establishing building lines and levels.
      6) Records of plant treatment.
      7) Ambient and substrate condition tests.
      8) Certifications received in lieu of labels on bulk products.
      9) Batch mixing and bulk delivery records.
      10) Testing and qualification of tradesmen.
      11) Documented qualification of installation firms.
      12) Load and performance testing.
      13) Inspections and certifications by governing authorities.
      14) Leakage and water-penetration tests.
      15) Fire-resistance and flame-spread test results.
      16) Final inspection and correction procedures.
      17) Pipe leakage test reports.
      18) Duct leakage test reports.
      19) Air and water balance reports.

G. Operation and Maintenance Manuals:

1. General Submission Requirements: The University of Maryland (UM) requires operation and maintenance manuals (O&MM) to be submitted in electronic "pdf" file format, by the CM, before substantial completion to the A/E and the University for review.

2. Product Data: All product data and shop drawing "pdf" files submitted during the shop drawing review phase must be complete per the requirements of the bid documents. These files can be either scanned as a "pdf" file or the files can be converted to "pdf" format provided the "pdf" files are clear and readable when either viewed on a computer monitor or printed on 8.5 x 11 or 11 x 17 paper. UM has examples of prints from electronic submittal files that are either acceptable or unacceptable and are available upon request. Contact the University project manager for file examples, if necessary.

3. General File Description: The following description outlines the organization of one (1) electronic O&MM file for each discipline such as, Architectural, Structural, Civil, Mechanical, and Electrical including the minimum documentation that shall be included in each O&MM file for each discipline. Each File shall be arranged as a stack file with bookmarks and a tree structure.

4. Arrangement: Arrange each O&MM file in a similar manner as a hard bound copy would be set up and submitted. For each discipline O&MM file include:

   a. Cover: Include the University Project Title, University Project Number, and Date.

   b. Table of Contents: Numeric List of each page with page 1 being the Cover Sheet, then each product submittal and shop drawing.

   c. Subcontractor List: List each subcontractor by company name, address, contact name and phone number for each approved product data submittal and/or approved shop drawing included in the file.

   d. Supplier List: List each manufacturer's company name, address, contact name and phone number for each approved product data submittal and/or approved shop drawing included in the file.

   e. Contractor Warranty Statement: Warranty statement in letter for the project warranty on the letter head of the mechanical contractor.

   f. Maintenance Chart: Include a maintenance chart for each piece of equipment or type of material that requires periodic maintenance. List the equipment and parts requiring the maintenance and the time interval.

g. Warranty and Instruction Information: Include any warranty information and/or manufacturers operating and maintenance instructions including replacement part's list with each product. Each product data submittal, shop drawing, warranty data, instructions shall be an individual "pdf" file for said data. Include Approved submittal data only.

5. General File Structure Example: Each discipline file structure shall be arranged using the structure example as follows:

   a. Table of Contents: Include the following:
      1) Cover Sheet
      2) Subcontractors List
      3) Suppliers List
      4) Contractor Warranty
      5) Maintenance Charts
      6) Discipline Specific Main Folders and Subfolders Content

6. Discipline O&MM Files: Each discipline O&MM files shall be arranged as follows:
   a. Architectural O&MM file include:
      1) Exterior: Include all submittals related to the Exterior.
      2) Interior: Include all submittals related to the Interior.
      3) Furnishings: Include all submittals related to the Furnishings.
      4) Equipment: Include all submittals related to the Equipment.
      5) Signage: Include all submittals related to the Signage.

   b. Structural O&MM file includes:
      1) Include all submittals related to Structural

   c. Civil O&MM file includes:
      1) Include all submittals related to Civil

   d. Mechanical O&MM file includes:
      1) Plumbing: Include all submittals related to Plumbing.
      2) HVAC: Include all submittals related to HVAC.
      3) Fire Protection: Include all submittals related to Fire Protection plus the complete fire protection drawings in "dwg" file format on a CD.

   e. Electrical O&MM file includes:
      1) Lighting: Include all submittals related to Lighting
      2) Power: Include all submittals related to Power

3) Fire Alarm: Include all submittals related to the Fire Alarm System plus the complete fire alarm drawings in "dwg" file format on a
4) Security: Include all submittals related to Security plus the complete security drawings in "dwg" file format on a CD.
5) Telecomm: Include all submittals related to telecomm plus the complete telecomm drawings in "dwg" file format on a CD.
6) Audio/visual: Include all submittals related to A/V plus the complete A/V drawings in "dwg" file format on a CD.

7. Discipline System File Name and "pdf" Tree Structure: Each Discipline System fie name and "pdf" tree structure including main folders and sub folders shall be arranged as follows:
   a. File Name: Architectural O&MM
      1) "PDF" Tree Structure – Main Folders
      a) Π Cover Sheet
      b) Π Table of Contents
      c) Π Subcontractor List
      d) Π Suppliers List
      e) Π Contractor Warranty
      f) Π Maintenance Charts
      g) Π Exterior
      h) Π Interior
      i) Π Furnishings
      j) Π Equipment
      k) Π Signage

   b. "PDF" Tree Structure – Main Topic - Sub Folders Example
      a) Π Furnishings
         (1) Π Laboratory Case Work
            (a) Π Approved Product Submittal File Product Data
            (b) Π Case Work Drawings
            (c) Π Manufacturers Warranty
            (d) Π Repeat Above sub folders for each approved product submittal

   c. File Name: Mechanical O&MM
      1) "PDF" Tree Structure – Main Folders
         a) Π Cover Sheet
         b) Π Table of Contents
         c) Π Subcontractor List
         d) Π Suppliers List
         e) Π Contractor Warranty

f) Π Maintenance Charts
g) Π Plumbing
h) Π HVAC
i) Π Fire Protection

2) "PDF" Tree Structure – Main Topic - Sub Folders Example
a) Π Plumbing
(1) Π Domestic Water Booster Pump
(a) Π Approved Product Submittal File
(b) Π Manufacturers Maintenance Data
(c) Π Manufacturers Warranty
b) Π Repeat Above sub folders for each approved product submittal

d. File Name: Electrical O&MM
1) "PDF" Tree Structure – Main Folders
a) Π Cover Sheet
b) Π Table of Contents
c) Π Subcontractor List
d) Π Suppliers List
e) Π Contractor Warranty
f) Π Maintenance Charts
g) Π Lighting
h) Π Power
i) Π Security
j) Π Fire Alarm
k) Π Telecomm
l) Π Audio Visual

2) "PDF" Tree Structure – Main Topic - Sub Folders Example
a) Π Lighting
(1) Π 2x4 Light Fixtures
(2) Π Approved Product Submittal File Product Data
(3) Π Manufacturers Maintenance Data
(4) Π Manufacturers Warranty
b) Π Repeat Above sub folders for each approved product submittal

1.9 INSTRUCTIONS FOR THE UNIVERSITY'S PERSONNEL

A. Prior to final inspection, instruct the University's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Provide instruction at mutually agreed upon times.

1. For equipment that requires seasonal operation, provide similar instruction during other seasons.
2. Use operation and maintenance manuals for each piece of equipment or system as the basis of instruction. Review contents in detail to explain all aspects of operation and maintenance.

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by the 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 2 - EXECUTION

3.1 CLOSEOUT PROCEDURES

A. Operation and Maintenance Instructions: Arrange for each Installer of equipment that requires regular maintenance to meet with the University's personnel to provide instruction in proper operation and maintenance. Provide instruction by manufacturer's representatives if installers are not experienced in operation and maintenance procedures. Include a detailed review of the following items:
   1. Maintenance manuals.
   2. Record documents.
   3. Spare parts and materials.
   4. Tools.
   5. Lubricants.
   6. Fuels.
   7. Identification systems.
   8. Control sequences.
   9. Hazards.
   10. Cleaning.
   11. Warranties and bonds.
   12. Maintenance agreements and similar continuing commitments.

B. As part of instruction for operating equipment, demonstrate the following procedures:
   1. Startup.
   2. Shutdown.
   3. Emergency operations.
   4. Noise and vibration adjustments.
   5. Safety procedures.
   6. Economy and efficiency adjustments.
   7. Effective energy utilization.

3.2 FINAL CLEANING

A. General: The General Conditions require general cleaning during construction. Regular site cleaning is included in Division 1 Section "Construction Facilities and Temporary Controls."
B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion.
    a. Clean the Project Site, yard and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and foreign substances.
    b. Sweep paved areas broom clean. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
    c. Remove petrochemical spills, stains, and other foreign deposits.
    d. Remove tools, construction equipment, machinery, and surplus material from the site.
    e. Remove snow and ice to provide safe access to the 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. Broom clean concrete floors in unoccupied spaces.
    i. Vacuum clean carpet and similar soft surfaces, removing debris and excess nap. Shampoo, if required.
    j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
    k. Remove labels that are not permanent labels.
    l. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
        1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
    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 if units were operated without filters during construction.
q. Clean food-service equipment to a sanitary condition, ready and acceptable for its intended use.
r. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs and defective and noisy starters in fluorescent and mercury vapor fixtures.
s. Leave the Project clean and ready for occupancy.

C. Removal of Protection: Remove temporary protection and facilities installed for protection of the Work during construction.

D. Compliance: Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the University's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from the site and dispose of lawfully.

1. Where extra materials of value remain after completion of associated Work, they become the University's property. Dispose of these materials as directed by the University.

END OF SECTION 01700

SECTION 019113 – GENERAL COMMISSIONING REQUIREMENTS
PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the administrative requirements related to commissioning and includes the following:

1. Definitions
2. Coordination
3. Quality control
4. Submittals
5. Design review and documentation
6. Test equipment
7. Commissioning process
8. Commissioning scope meetings
9. Commissioning plans
10. Submittal review
11. Commissioning controls coordination meeting
12. Startup/Pre functional check lists
13. Functional performance testing
14. Issue log
15. Operations and maintenance training
16. Final commissioning report
17. Deferred seasonal testing
18. Team responsibilities

B. The Owner, Architect/Engineer, and Commissioning Agent are not responsible for construction means, methods, job safety, or management function related to commissioning on the job site.

1. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

2. The mention of a subcontractor is not meant to usurp the Contractor's responsibility to assign the work.

C. Related Sections:

1. 014000 Quality Requirements
2. 017700 Closeout Procedures
3. 017900 Demonstration and Training
4. 260000 General Requirements Electrical Systems
5. 260800 Commissioning Electrical System

1.2 DEFINITONS

A. Basis of Design (BOD): The Basis of Design document is a specific Commissioning document that describes the systems, components, conditions and methods chosen by the design engineer to meet the requirements of the project. Some reiteration of the Owner's Project Requirements may be included.

B. Commissioning (Cx): Commissioning is a comprehensive and systematic process to verify that the building systems perform as designed to meet the Owner's requirements. Commissioning during the construction, acceptance and warranty phases is intended to achieve the following specific objectives:

1. Verify and document that the equipment is installed and started per manufacturer's recommendations, industry accepted minimum standards, and the Contract Documents.

2. Verify and document that the equipment and systems receive complete operational checkout by installing contractors.

3. Verify and document equipment and system performance.

4. Verify the completeness of the Operations and Maintenance materials.

5. Ensure that the Owner's operating personnel are adequately trained on the operation and maintenance of building equipment.

6. The commissioning process does not take away from or reduce the responsibility of the systems designers or installing contractors to provide a finished and fully functioning product.

C. Commissioning Agent (CxA): The commissioning agent develops the functional test procedures in a sequential written form, coordinates, oversees, and documents the actual testing, which is usually performed by the installing contractor or vendor. Functional Performance Tests are performed after pre-functional checklists and startup is complete.

D. Commissioning Plan: The commissioning plan is an overall plan that provides the structure, schedule, and coordination planning for the commissioning process.

E. Deficiency: A deficiency is a condition in the installation or function of a component, piece of equipment, or system that is not in compliance with the Contract Documents, does not perform properly, or is not complying with the Owner's Project Requirements.

F. Owner's Project Requirements (OPR): The OPR is a specific Commissioning document that is updated throughout the project that provides the explanation of the ideas, concepts,

and criteria that are considered to be very important to the Owner. It is initially the outcome of the programming and conceptual design process.

G. Functional Performance Test (FPT): The FPT is a test of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the dynamic testing of systems (rather than just components) under full operation (e.g. the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failure, unoccupied, varying outside air temperatures, fire alarm power failure, and any other operational sequence included in the system design. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Traditional air or water test and balancing (TAB) is not functional testing, in the commissioning sense of the word. TAB's primary work is setting up the system flows and pressures as specified, while functional testing is verifying that which has already been set up. The CxA develops the functional test procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is usually performed by the installing contractor or vendor. Functional Performance Tests are performed after prefunctional checklists and startup is complete.

H. Prefunctional Checklist: The pre-functional check list is a list of items to inspect and elementary component test to conduct to verify proper installation of equipment, provided by the CxA to the contractor. Prefunctional checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g. belt tension, oil levels OK, labels affixed, gages in place, sensors calibrated). However, some prefunctional checklist items entail system testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three-phase pump motor of a chiller system). The word "prefunctional" refers to before functional testing. Prefunctional checklists augment and are combined with the manufacturer's start-up checklist.

I. Warranty Period: The warranty period is for the entire project, including equipment components. Warranty begins at Substantial Completion and extends for two years, unless specifically noted otherwise in the Contract Documents and accepted submittals.

J. Abbreviations: The following are common abbreviations used in the Commissioning Specification:

1. A/E - Architect and Engineers
2. CxA - Commissioning Agent
3. CC - Controls Contractor
4. Cx Plan - Commissioning Plan document
5. FPT - Functional Performance Test

6. GC - General Contractor
7. MEP – Mechanical, Electrical, Plumbing
8. PM - Project Manager (University)
9. Subs - Subcontractors to the General Contractor
10. TAB - Test and Balance Contractor

1.3 COORDINATION

A. The owner will hire a third-party Commissioning Agent (CxA). The contractor and the contractor's team shall be responsible for assisting the CxA in commissioning activities.

B. Commissioning Agent (CxA) shall provide overall coordination and management of the commissioning program as specified herein.

C. Commissioning Team: The commissioning process will require the cooperation of the Contractor, subcontractors, vendors, Architect/Engineer, Commissioning Agent, and Owner. The commissioning team shall be comprised of the following. Team member responsibilities are listed in Part 3 of this section.

1. Commissioning Agent:

   a. Project Manager
   b. Project Technicians

2. Contractor and Sub-contractors as required.

3. Owner Representative(s)

4. Architect/Engineer:

   a. Architect
   b. MEP Engineers
   c. Specialty Consultant(s)

D. Progress Meetings: Attend construction job-site meetings, as necessary, to monitor construction and commissioning progress. Coordinate with contractor to address coordination, deficiency resolution, and planning issues.

1. Plan and coordinate additional meetings as needed based on work progress.

E. Site Observations: Perform site visits as necessary to observe component and system installations.

F. Functional Testing Coordination:

1. Equipment shall not be "temporarily" started for commissioning.
2. Functional performance testing shall not begin until pre-functional check, start-up, and TAB are completed for a given system.
3. The controls system and equipment controls shall not be functionally tested until all points have been calibrated and pre-functional checklists are complete.

1.4 QUALITY CONTROL

A. Engage commissioning service personnel that specialize in the types of inspections and tests to be performed.

B. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems of the systems to be commissioned.

1.5 SUBMITTALS

A. Cx Meeting Minutes:

1. CxA shall be responsible for preparing meeting minutes and provide to Owner's PM for distribution.

B. Commissioning Plan:

1. Contractor shall be responsible for reviewing the Commissioning plan, provided by the CxA, and incorporating into project schedule.

C. Pre-Functional Checklists:

1. Contractor shall be responsible for completing pre-functional checklists (prepared by CxA). The contractor shall allow five days for review of completed PFC's before FPT's are scheduled to begin.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. The contractor will make available standard testing equipment required to perform startup, initial checkout and functional performance testing as well as any special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents.

B. Data Logging equipment and software required to test equipment shall be provided by the Contractor, but shall not become property of the Owner.

C. Instrumentation shall meet the following standards:

1. Be of sufficient quality and accuracy to test and measure system performance within the tolerances required to determine adequate performance.
2. Be calibrated on the manufacturer's recommended intervals with calibration tags permanently affixed to the instrument being used.
3. Be maintained and in good repair and operational condition throughout the duration of use on this project.

D. Test Equipment Calibration Requirements: Contractors shall comply with test equipment manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired after being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

PART 3 - EXECUTION

3.1 COMMISSIONING PROCESS

A. The following activities outline the commissioning tasks and the general order in which they occur. The CxA shall coordinate all activities.

1. Design Review and Documentation:
    a. Basis of Design and Owner's Project Requirements Review
    b. Design Document Review
    c. Controls Coordination Review Meeting
    d. Construction Document Review
2. Commissioning Scoping Meetings
3. Commissioning Plan
4. Submittal Review:
    a. General systems to be Commissioned
    b. Controls Submittal Review
5. Commissioning Controls Coordination Meeting
6. Start-Up / Pre-functional Checklists
7. Functional Performance Testing
8. Issues Log
9. Operations and Maintenance Training
10. Final Commissioning Report
11. Deferred and Seasonal Testing

3.2 COMMISSIONING SCOPE MEETINGS

A. Commissioning Scope Meeting – Design Phase:

1. Attend a scope meeting during the design phase prior to the first design review.
2. Cx Team members who have been hired during the design phase shall be in attendance.

3. Review the Cx process with special attention on the design phase requirements.

B. Commissioning Scope Meeting – Construction Phase:

1. Attend a scoping meeting at the start of construction after the subcontractors have been selected.
2. All Cx Team members shall be in attendance.
3. Review the Cx process with special attention on the construction phase requirements.

3.3 COMMISSIONING CONTROLS COORDINATION MEETING

A. Meeting Attendees:

1. CxA
2. Controls Contractor
3. Engineer of Record
4. Owner's Representatives
5. Contractor
6. Architect

B. After the first controls submittal review is complete, schedule, coordinate and facilitate the Commissioning Controls Coordination Meeting.

C. Review all submittal review comments with the group and, as a group, determine the required resolution for each comment. Controls resubmittal shall be submitted within two (2) weeks of this meeting.

3.4 START-UP / PRE-FUNCTIONAL CHECKLISTS

A. Start-up/Pre-Functional Checklists: Coordinate start-up plans and documentation formats, including providing contractor with pre-functional checklists to be completed during the start-up process.

1. Manufacturer's start-up checklists and other technical documentation guidelines may be used as the basis for pre-functional checklists. CxA will coordinate with the Contractor to obtain manufacturer data as needed.

B. Start-up/Pre-Functional Checklists are used to verify that the systems are complete and operational before functional testing is scheduled.

3.5 FUNCTIONAL PERFORMANCE TESTING

A. Functional Performance Tests (FPT): Test procedures shall fully describe system configuration and steps required for each test; appropriately documented so that the test can be repeated with virtually identical results.

1. Test Methods: Functional performance testing and verification may be achieved using a combination of the following methods to test the complete sequence of operation. The CxA shall determine which method, or combination, is most appropriate:

    a. Direct manipulation of system inputs (i.e. applying heat or cold to sensors).
    b. Manipulation of system inputs with the building automation software (i.e. software override of sensor inputs)
    c. Direct observation of equipment readouts, gauges, and actuators.
    d. Trend logs of system inputs and outputs using the building automation system
    e. Short-term monitoring of system inputs and outputs using stand alone data loggers.

2. Setup: Setup each test procedure to be performed under conditions that simulate normal operating conditions as closely as possible. Where equipment requires integral safety devices to stop/prevent equipment operation unless minimum safety standards or conditions are met, functional performance test procedures shall demonstrate the actual performance of safety shutoffs in a real or closely-simulated condition of failure.

3. Sampling: Multiple identical pieces of non-life-safety or non-critical equipment may be functionally tested using a sampling strategy. The sampling strategy shall be developed by the CxA. If, after three attempts at testing the specified sample percentage, failures are still present, then all remaining units shall be tested at the contractor's expense. Sampling may only be used as agreed upon in the Cx contract.

4. Trending: Identify conditions where trend data from the building automation system or data loggers can be used to verify sequence of operation performance. Include trend log requirements in FPT documentation.

B. Assist CxA in completing FPT's as directed by the CxA.

3.6 ISSUES LOG

A. Issues are items of non-compliance in materials, installation, or operation observed by the CxA.

B. The CxA shall notify responsible parties upon observation of deficiencies or issues of non-compliance. CxA shall recommend corrective actions as appropriate. Issues that are not immediately resolved shall be placed on the Issues Log.

C. The CxA shall update the Issues Log and submit it to the PM for distribution to all members of the Cx Team when changes are made.

D. Those identified as "Responsible" for a specific issue shall respond within three (3) days of receiving an updated Issues Log with the planned resolution.

1. "Responsible" indicates the party who is responsible for responding to the open issue, it does not imply responsibility for creating the issue. For example, if the issue relates to a temperature set-point, the Owner may be listed as the responsible party for providing the desired value.

2. Any member of the design and construction team may be identified to respond to Cx Issues. Team members are responsible for responding to design and construction questions raised during commissioning work.

3.7 TEAM RESPONSIBILITIES

A. Owner's Responsibilities:

1. Owner will hire the third party CxA.

2. Provide the OPR documentation to the CxA and Contractors for use in developing the Cx Plan, testing plans, and checklists.

3. Provide the Basis of Design documents, prepared by the architect and approved by the Owner, for use in developing the Commissioning Plan; testing plans and checklists.

4. Assign operation and maintenance personnel and schedule them to participate in Commissioning Team activities including, but not limited to, the following:

a. Commissioning meetings.
b. Construction phase coordination meetings.
c. Piping and ductwork testing and flushing verification meetings.
d. Procedures meeting for testing, adjusting and balancing.
e. Testing and demonstration of systems, subsystems and equipment.
f. Training in operation and maintenance of systems, subsystems and equipment.
g. Final review and acceptance meetings.
h. Provide utility services required for the commissioning process.
i. Review and approve the commissioning plan.
j. Coordinate any seasonal or deferred testing.
k. Ensure that any seasonal, deferred testing and/or deficiency issues are addressed.

B. Architect / Engineer's Responsibilities:

1. Attend the Commissioning Scoping Meetings, Controls Coordination Meetings, and selected team meetings.

2. Perform submittal review, construction observation, as-built drawing preparation, and other items as contracted.

3. Provide the Basis of Design Document. The design engineers shall assist in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

4. Participate in the resolution of system deficiencies and issues identified during the commissioning, according to the contract documents.

5. Insure that the CxA's submittal comments are incorporated into the Design Professional's submittal comments prior to sending to CM for distribution.

6. Participate in resolution of design non-conformance and design deficiencies identified during the warranty-period commissioning process.

C. Contractor, and Subcontractor Responsibilities:

1. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following brief overview:

   a. Facilitate the coordination of commissioning and incorporate commissioning activities into the overall project.
   b. Provide copies of all applicable submittals as required in the specifications including all changes.
   c. Provide detailed startup procedures.
   d. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, perform corrective actions.
   e. Cooperate with the CxA for resolution of issues recorded in the Issues Log.
   f. Attend commissioning team meetings held on a scheduled basis.
   g. Make available a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CxA.
   h. Integrate and coordinate commissioning process activities with construction schedule.
   i. Review construction checklists provided by the CxA.

j. Review commissioning process test procedures provided by the CxA.
k. Complete commissioning process test procedures.
l. Submit training plan for approval, coordinate training and provide qualified instructors for training of Owner personnel.
m. Assist the CxA as necessary in the seasonal testing, deferred testing and deficiency resolution.
n. Ensure that subcontractors correct deficiencies and make necessary adjustments to submittals, O&M manuals and red-lined drawings for applicable issues identified during testing.
o. Provide as-built controls drawings and sequences of operation for all equipment.
p. Provide a written list of all user adjustable set-points and reset schedules with a brief discussion of the purpose of each and the range of reasonable adjustments with energy implications.

2. Equipment Supplier Responsibilities:

a. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.
b. Assist in equipment testing per agreements with subcontractors.
c. Provide information requested by the CxA regarding equipment sequence of operation and testing procedures.

3. Commissioning Agent Responsibilities:

a. Roles and Responsibilities:

1) The CxA is not responsible for the design concept, the design criteria, compliance with codes, design or general construction scheduling, cost estimating or construction management.
2) The CxA may assist with problem solving and non-conformance items or deficiencies, but the CxA is not the Engineer of Record, and the commissioning process does not preclude the Engineer of Record of responsibilities for system evaluations, adequacy of systems to meet the OPR, capacities of systems, quality control checks, or any of the other elements and recommended final acceptance of systems to the Owner.
3) The primary role of the CxA is to coordinate and direct the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultants with all necessary parties, frequently updated timelines and schedules and technical expertise.

b. Commissioning Plan:

1) The CxA shall develop a Commissioning Plan at the start of the project.
2) At the end of the Project, the CxA shall provide the Owner with the Final Commissioning Plan for the Owner's use.

c. Document Review:

1) Review the Owner's Project Requirements and Basis of Design developed by the design professionals.
2) Perform two (2) focused reviews of the drawings and specification during design phase.
3) Develop full commissioning specifications for all systems and equipment to be commissioned. The commissioning specifications will be subject to approval of the design team and included in the final construction specifications.
4) Review submittals applicable to systems being commissioned for compliance for commissioning needs, concurrent with the AE's reviews.

d. Cx Team Meetings:

1) Lead Cx Meetings during design and construction.

e. Coordination and Scheduling:

1) Coordinate and direct commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications, and consultations with all necessary parties.
2) Coordinate commissioning work with the CM to ensure that commissioning activities are being scheduled into the master project schedule.

f. Commissioning Progress:

1) Perform site visits, as necessary, to observe component and system installations.
2) Attend selected planning and jobsite meetings to obtain information on construction progress.
3) Review construction meeting minutes for revisions/substitutions relating to the commissioning process.

g. Pre-Functional Checks:

1) Verify proper installation of components, equipment, systems and assemblies.

h. Equipment and System Startup and Verification:

1) Review system startup reports and conduct selected site observation.
2) Perform TAB verification per contract requirements, and review the TAB report prior to functional testing.
3) Functional Performance Testing
4) With assistance from the Contractor, write Functional Performance Test procedures for all components, equipment or systems to be commissioned.
5) With the assistance of the Contractors, coordinate Functional Performance Testing. Witness and approve Functional Performance Testing performed by the Contractors.

i. With the assistance of the Contractors, coordinate retesting as necessary until satisfactory performance is achieved.
j. Witness seasonal or deferred Functional Performance Testing as necessary.

4. Issue/Deficiency Logs:

a. Prepare a formal, ongoing, online record of deficiencies, problems and concerns – and their resolution – raised by members of the Commissioning Team during the Commissioning Process.
b. Issues will be recorded in the Issues Log. The AE, CM/GC and Contractors will resolve all issues to the satisfaction of the Owner. Issues will be added by the CxA. Team members are required to respond to issues pertaining to their work. Team members are required to respond to issues added to the list within five (5) working days of issue of an update to the Issues Log.
c. When issues are resolved, they will be closed on the Issues Log by the CxA.

5. Operation and Maintenance Data:

a. The CxA shall review of the documentation submitted by the Contractor as required by the Specifications for completeness and accuracy. This commissioning review supplements, but does not replace, the Architect/Engineer's review.
b. Review equipment warranties to ensure that the Owner's responsibilities are clearly defined.

6. Training:

   a. The CM/GC and Contractors will provide all documentation and qualified training personnel for training.
   b. The CxA will verify through the Contractor's plan and schedule, training agendas, and attendance documentation that proper training procedures were followed on all commissioned systems.
   c. See specifications for training requirements.

7. Commissioning Final Report:

   a. The CxA shall provide a final report following the completion of all Functional Performance Testing.

END OF SECTION 019100

SECTION 024119 - SELECTIVE STRUCTURE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Demolition and removal of selected portions of building or structure.
2. Salvage of existing items to be reused or recycled.

B. Related Sections include the following:

1. Section 011000 "Summary" for use of premises**,** and phasing, and Owner-occupancy requirements.
2. Section 015000 "Temporary Facilities and Controls" for temporary construction and environmental-protection measures for selective demolition operations.
3. Section 017300 "Execution" for cutting and patching procedures.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be either removed and salvaged, or removed and reinstalled.

B. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

A. Coordinate storage of any salvage items for reuse with Building Owner's representative.

1.5 SUBMITTALS

A. Qualification Data: For demolition firm.

B. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's building manager's and other tenants' on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator, stairs and loading dock.
5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
6. Means of protection for items to remain and items in path of waste removal from building.

C. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.

D. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1. Comply with submittal requirements in Section 017419 "Construction Waste Management and Disposal."

1.6 QUALITY ASSURANCE

A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.

B. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

C. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

D. Standards: Comply with ANSI A10.6 and NFPA 241.

1.7 PROJECT CONDITIONS

A. Tenants will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Tenants' operations will not be disrupted.

1. Comply with requirements specified in Section 011000 "Summary."

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

1. Before selective demolition, Owner will remove salvage items.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. Hazardous materials will be removed by Owner before start of the Work.
2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Owner will remove hazardous materials under a separate contract.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

1.8 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.

D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

E. Survey of Existing Conditions: Record existing conditions by use of measured drawings and preconstruction photographs.

1. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.

1. Comply with requirements for existing services/systems interruptions specified in Division 1 Section "Summary."

B. Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Coordinate with Building Owner and Tenants prior to arranging to shut off indicated utilities with utility companies.
2. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
3. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

a. Where entire wall is to be removed, existing services/systems may be removed with removal of the wall.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Comply with requirements for access and protection specified in Section 015000 "Temporary Facilities and Controls."

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
5. Maintain adequate ventilation when using cutting torches.

6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
9. Dispose of demolished items and materials promptly.

B. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in small sections. Cut concrete to a depth of at least 3/4 inch at junctures with construction to remain, using power-driven saw. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete indicated for selective demolition. Neatly trim openings to dimensions indicated.

B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.

C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

E. Resilient Floor Coverings: Remove floor coverings and adhesive.

1. Remove residual adhesive and prepare substrate for new floor coverings.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.7 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119

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SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

    a. Contractor's superintendent.
    b. Independent testing agency responsible for concrete design mixtures.
    c. Ready-mix concrete manufacturer.
    d. Concrete Subcontractor.

2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, forms and form removal limitations, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, methods for achieving specified floor and slab flatness and levelness

floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Laboratory Test Reports: For liquid floor treatments and curing and sealing compounds, indicating compliance with requirements for low-emitting materials.

C. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

D. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

E. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1. Location of construction joints is subject to approval of the Architect.

F. Samples: For waterstops and vapor retarder.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.

5. Fiber reinforcement.
6. Waterstops.
7. Curing compounds.
8. Floor and slab treatments.
9. Bonding agents.
10. Adhesives.
11. Vapor retarders.
12. Semirigid joint filler.
13. Joint-filler strips.
14. Repair materials.

C. Material Test Reports: For the following, from a qualified testing agency:

1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.

1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

E. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

F. Field quality-control reports.

G. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Testing Agency Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

1.10 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water

equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301.
2. ACI 117.

2.2 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

    a. High-density overlay, Class 1 or better.
    b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
    c. Structural 1, B-B or better; mill oiled and edge sealed.
    d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

3. Overlaid Finnish birch plywood.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

F. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

G. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

H. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

I. Form Ties: Factory-fabricated, removable or snap-off glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.3 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 60 percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

C. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

D. Galvanized Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed bars, ASTM A 767/A 767M, Class II zinc coated after fabrication and bending.

E. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed bars, ASTM A 775/A 775M, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.

F. Stainless-Steel Reinforcing Bars: ASTM A 955/A 955M, Grade 60, Type 316L, deformed.

G. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60, deformed bars, assembled with clips.

H. Plain-Steel Wire: ASTM A 1064/A 1064M, as drawn.

I. Deformed-Steel Wire: ASTM A 1064/A 1064M.

J. Epoxy-Coated Wire: ASTM A 884/A 884M, Class A, Type 1 coated, as-drawn, plain - steel wire, with less than 2 percent damaged coating in each 12-inch wire length.

K. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.

L. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, flat sheet.

M. Galvanized-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from galvanized-steel wire into flat sheets.

N. Epoxy-Coated Welded-Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, plain steel.

2.4 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, ASTM A 775/A 775M epoxy coated.

C. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.

D. Zinc Repair Material: ASTM A 780/A 780M.

E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
3. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

2.5 CONCRETE MATERIALS

A. Regional Materials: Concrete shall be manufactured within 500 miles of Project site from aggregates and cementitious materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

B. Regional Materials: Concrete shall be manufactured within 500 miles of Project site.

C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

D. Cementitious Materials:

1. Portland Cement: ASTM C 150/C 150M, Type I, Type II, Type I/II, or Type III; gray.
2. Fly Ash: ASTM C 618, Class F or C.
3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.
4. Silica Fume: ASTM C 1240, amorphous silica.

E. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 4S for exterior, Class 4M for interior, coarse aggregate or better, graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 1 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

F. Lightweight Aggregate: ASTM C 330/C 330M, 3/4-inch nominal maximum aggregate size.

G. Air-Entraining Admixture: ASTM C 260/C 260M.

H. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

I. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier

and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:

    a. BASF Corporation-Construction Systems; MasterLife CI 30 (Pre-2014: Rheocrete CNI).
    b. Euclid Chemical Company (The); an RPM company; EUCON CIA.
    c. Grace Construction Products; W.R. Grace & Co. -- Conn.; DCI.
    d. Sika Corporation; Sika CNI.

J. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. BASF Corporation-Construction Systems; MasterLife CI 222 (Pre-2014: Rheocrete 222+).
    b. Cortec Corporation; MCI- 2005NS.
    c. Grace Construction Products; W.R. Grace & Co. -- Conn.; DCI-S.
    d. Sika Corporation; FerroGard 901.

K. Water: ASTM C 94/C 94M and potable.

2.6 FIBER REINFORCEMENT

A. Synthetic Micro-Fiber: Fibrillated polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 incheslong.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Euclid Chemical Company (The); an RPM company; PSI Fiberstrand F.
    b. FORTA Corporation; FORTA Econo-Net, FORTA Super-Net, FORTA Ultra-net.
    c. Grace Construction Products; W.R. Grace & Co. -- Conn.; Grace Fibers.
    d. Nycon, Inc.; ProCon-F -–E, [ProConF.
    e. Propex; Fibermesh 300.
    f. Sika Corporation; Sika Fiber PPF.

2.7 WATERSTOPS

A. Flexible Rubber Waterstops: CE CRD-C 513,[with factory-installed metal eyelets,] for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Products: Subject to compliance with requirements, provide the following:

a. Williams Products, Inc; <Insert product designation>.

2. Profile: [Flat dumbbell with center bulb] [Flat dumbbell without center bulb] [Ribbed with center bulb] [Ribbed without center bulb] [As indicated] <Insert profile>.
3. Dimensions: [4 inches by 3/16 inch thick] [6 inches by 3/8 inch thick] [9 inches by 3/8 inch thick] <Insert dimensions>; nontapered.

B. Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops[with factory-installed metal eyelets], for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals. Factory fabricate corners, intersections, and directional changes.

1. Products: Subject to compliance with requirements, provide one of the following:

a. JP Specialties, Inc.; Earth Shield TPV.
b. Sika Corporation; WESTEC Envirostop.

2. Profile: [Flat dumbbell with center bulb] [Flat dumbbell without center bulb] [Ribbed with center bulb] [Ribbed without center bulb] [As indicated] <Insert profile>.
3. Dimensions: [4 inches by 3/16 inch thick] [6 inches by 3/16 inch thick] [6 inches by 3/8 inch thick] [9 inches by 3/16 inch thick] [9 inches by 3/8 inch thick] <Insert dimensions>; nontapered.

C. Flexible PVC Waterstops: CE CRD-C 572,[with factory-installed metal eyelets,] for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Products: Subject to compliance with requirements, provide one of the following:

a. BoMetals, Inc; <Insert product designation>.
b. Paul Murphy Plastics Company; <Insert product designation>.
c. Sika Greenstreak; Sika Greenstreak PVC Waterstop.
d. Vinylex Waterstop & Accessories; <Insert product designation>.

2. Profile: [Flat dumbbell with center bulb] [Flat dumbbell without center bulb] [Ribbed with center bulb] [Ribbed without center bulb] [As indicated] <Insert profile>.

3. Dimensions: [4 inches by 3/16 inch thick] [6 inches by 3/8 inch thick] [9 inches by 3/8 inch thick] <Insert dimensions>; nontapered.

D. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Carlisle Coatings & Waterproofing Inc; MiraSTOP.
b. CETCO, a Minerals Technologies company; [Waterstop-RX-101] [Waterstop-RX-101T] [Waterstop-RX-102].
c. Concrete Sealants Inc.; Conseal CS-231.
d. Henry Company, Sealants Division; Hydro-Flex.
e. JP Specialties, Inc.; Earth Shield Type 20.
f. Sika Greenstreak; Swellstop.

E. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer-modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Adeka Ultra Seal/OCM, Inc.; [Adeka Ultra Seal MC-2005T] [Adeka Ultra Seal MC-2010MN].
b. CETCO, a Minerals Technologies company; Akwastop.
c. Grace Construction Products; W.R. Grace & Co. -- Conn.; Adcor ES.
d. Sika Greenstreak; Hydrotite.

2.8 VAPOR RETARDERS

A. Sheet Vapor Retarder: ASTM E 1745, Class A[, except with maximum water-vapor permeance of <Insert rating>]. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fortifiber Building Systems Group; [Moistop Ultra 10] [Moistop Ultra 15].
b. Grace Construction Products; W.R. Grace & Co. -- Conn.; Florprufe 120.
c. Insulation Solutions, Inc.; [Viper VaporCheck II 10-mil] [Viper VaporCheck II 15-mil].
d. Poly-America, L.P.; [Husky Yellow Guard Vapor Barrier 15 Mil ASTM E-1745 Class A] [Husky Yellow Guard Vapor Retarder 10 Mil ASTM E-1745 Class A].
e. Raven Industries, Inc; [Vapor Block 10] [Vapor Block 15] [Vapor Block VB10] [Vapor Block VB15].

f. Reef Industries, Inc; [Griffolyn 10 mil Green] [Griffolyn 15 mil Green] [Griffolyn Type-105] [Griffolyn Type-65G].
g. Stego Industries, LLC; [Stego Wrap 10 mil Class A] [Stego Wrap 15 mil Class A].
h. Tex-Trude, Inc.; [Xtreme 10 Mil Underslab Vapor Barrier] [Xtreme 15 mil Vapor Barrier] [Xtreme 20 mil Vapor Barrier].
i. W.R. Meadows, Inc; [Perminator 10 mil] [Perminator 15 mil].

B. Sheet Vapor Retarder: ASTM E 1745, Class B[, except with maximum water-vapor permeance of <Insert rating>]. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fortifiber Building Systems Group; Moistop Ultra 6.
b. Reef Industries, Inc; [Griffolyn 10 mil Green] [Griffolyn Type-85] [Griffolyn Vaporguard].

C. Sheet Vapor Retarder: ASTM E 1745, Class C[, except with maximum water-vapor permeance of <Insert rating>]. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Insulation Solutions, Inc.; [Viper VaporCheck II 10 mil] [Viper VaporCheck II 6-mil].
b. Raven Industries, Inc; Vapor Block VB6.
c. Reef Industries, Inc; Griffolyn Type-65.
d. Stego Industries, LLC; Stego Wrap, 10 mil Class C.
e. Tex-Trude, Inc.; Xtreme 10 mil Class C.

D. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils thick.

E. Bituminous Vapor Retarder: 110-mil- thick, semiflexible, seven-ply sheet membrane consisting of reinforced core and carrier sheet with fortified asphalt layers, protective weathercoating, and removable plastic release liner. Furnish manufacturer's accessories, including bonding asphalt, pointing mastics, and self-adhering joint tape.

1. Products: Subject to compliance with requirements, provide the following:

a. W.R. Meadows, Inc; Premoulded Membrane Vapor Seal.

2. Water-Vapor Permeance: 0.0011 grains/h x sq. ft. x inches Hg; ASTM E 154.

3. Tensile Strength: 140 lbf/inch; ASTM E 154.
4. Puncture Resistance: 90 lbf; ASTM E 154.

2.9 FLOOR AND SLAB TREATMENTS

A. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing [3/8-inch] [No. 4] [No. 8] <Insert size or gradation> sieve.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Anti-Hydro International, Inc; A-H Emery Non-Slip.
b. Dayton Superior; [Emery Non-Slip][Emery Tuff Top].
c. L&M Construction Chemicals, Inc; Grip It.
d. Lambert Corporation; EMAG-20.
e. Metalcrete Industries; Met-Top E.

B. Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Anti-Hydro International, Inc; A-H Alox.
b. BASF Corporation-Construction Systems; MasterTop 120 SR (Pre-2014: Frictex NS).
c. L&M Construction Chemicals, Inc; Grip It AO.

C. Emery Dry-Shake Floor Hardener: [Pigmented] [Unpigmented], factory-packaged, dry combination of portland cement, graded emery aggregate, and plasticizing admixture; with emery aggregate consisting of no less than 60 percent of total aggregate content.

1. Color: [As indicated by manufacturer's designation] [Match Architect's sample] [As selected by Architect from manufacturer's full range].

D. Metallic Dry-Shake Floor Hardener: [Pigmented] [Unpigmented], factory-packaged, dry combination of portland cement, graded metallic aggregate, rust inhibitors, and plasticizing admixture; with metallic aggregate consisting of no less than 65 percent of total aggregate content.

1. Color: [As indicated by manufacturer's designation] [Match Architect's sample] [As selected by Architect from manufacturer's full range].

E. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. BASF Corporation-Construction Systems; Maximent HD.
    b. Dayton Superior; Quartz Tuff.
    c. Euclid Chemical Company (The); an RPM company; Surflex.
    d. Kaufman Products, Inc; Tycron.
    e. L&M Construction Chemicals, Inc; Quartzplate FF.
    f. Lambert Corporation; Colorhard.
    g. Metalcrete Industries; Floor Quartz.
    h. Scofield, L. M. Company; Lithochrome Color Hardener.
    i. SpecChem, LLC; Quartz Hardener.

F. Pigmented Mineral Dry-Shake Floor Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Anti-Hydro International, Inc; A-H S-Q Hardener.
    b. BASF Corporation-Construction Systems; MasterTop 100 (Pre-2014: Mastercron).
    c. Bon Tool Co.; BonWay Concrete Color Hardener.
    d. Brickform; a division of Solomon Colors; CH-Color Hardener.
    e. Butterfield Color; Perma-Cast Shake-On Color Hardener.
    f. Dayton Superior; Quartz Tuff.
    g. Decosup Inc.; HardBright Color Hardener.
    h. Dynamic Color Solutions, Inc; Dynamicast Color Hardener.
    i. Euclid Chemical Company (The); an RPM company; Surflex.
    j. H&C Concrete Care Products; Dry-Shake Color Hardener.
    k. Kaufman Products, Inc; Tycron.
    l. L&M Construction Chemicals, Inc; Quartz Plate FF.
    m. Lambert Corporation; Colorhard.
    n. Metalcrete Industries; Floor Quartz.
    o. Proline Concrete Tools, Inc.; Dura-Color Hardener.
    p. QC Construction Products; [QC Color Hardener] [QC Heavy-Duty Color Hardener].
    q. Scofield, L. M. Company; Lithochrome Color Hardener.
    r. SpecChem, LLC; Quartz Hardener - Colored.
    s. Specialty Concrete Products, Inc; CHROME-HARD Color Hardener.
    t. Stampcrete International, Ltd; Color Hardener.
    u. SuperStone, Inc; Color Hardener.
    v. SureCrete Design Products; Color Hardener.

2. Color: [As indicated by manufacturer's designation] [Match Architect's sample] [As selected by Architect from manufacturer's full range].

2.10 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. AWRC Corporation; AMERI-SHIELD Shield-Proof.
   b. ChemMasters, Inc; Chemisil Plus.
   c. ChemTec Int'l; ChemTec One.
   d. Curecrete Distribution Inc.; Ashford Formula.
   e. Dayton Superior; [Pentra-Hard Densifier] [Pentra-Hard Finish] [Pentra-Hard Guard] [Sure Hard Densifier J17].
   f. Euclid Chemical Company (The); an RPM company; Euco Diamond Hard.
   g. Kaufman Products, Inc; SureHard.
   h. L&M Construction Chemicals, Inc; Seal Hard.
   i. Metalcrete Industries; Floorsaver.
   j. Nox-Crete Products Group; Duro-Nox.
   k. PROSOCO, Inc; Consolideck LS by PROSOCO.
   l. SpecChem, LLC; SpecHard.
   m. US SPEC, Division of US MIX Company; US SPEC Industraseal.
   n. Vexcon Chemicals Inc.; Vexcon StarSeal PS Clear.
   o. W.R. Meadows, Inc; LIQUI-HARD.

2. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.11 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. BASF Corporation-Construction Systems; Confilm.
   b. Bon Tool Co.; 32-301-B7 BonWay Evaporation Retarder.
   c. Brickform; a division of Solomon Colors; Evaporation Retarder.
   d. ChemMasters, Inc; Spray-Film.
   e. Dayton Superior; AquaFilm Concentrate J74 or AquaFilm J74RTU.
   f. Euclid Chemical Company (The); an RPM company; Eucobar.
   g. Kaufman Products, Inc; VaporAid.
   h. L&M Construction Chemicals, Inc; E-CON.

i. Lambert Corporation; LAMBCO Skin.
j. Metalcrete Industries; Waterhold.
k. Nox-Crete Products Group; MONOFILM.
l. Sika Corporation; Caltexol CIMFILM or SikaFilm.
m. SpecChem, LLC; Spec Film.
n. TK Products; TK-2120 TRI-FILM.
o. Vexcon Chemicals Inc.; Certi-Vex EnvioAssist.
p. W.R. Meadows, Inc; EVAPRE.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

1. Products: Subject to compliance with requirements, provide one of the following:

a. AWRC Corporation; AMERI-SHIELD Shield-Sheen WB 20.
b. BASF Corporation-Construction Systems; MasterKure CC 200 WB (Pre-2014: Kure-N-Seal W).
c. ChemMasters, Inc; Polyseal WB.
d. Dayton Superior; Cure & Seal 1315 J22 WB.
e. Euclid Chemical Company (The); an RPM company; Diamond Clear VOX.
f. L&M Construction Chemicals, Inc; Dress & Seal WB.
g. Lambert Corporation; Glazecote Sealer-20.
h. Metalcrete Industries; Metcure 0800.
i. Nox-Crete Products Group; Cure & Seal 200E or Cure & Seal 250 E.
j. SpecChem, LLC; Cure & Seal WB 25.
k. Vexcon Chemicals Inc.; Starseal 0800.
l. W.R. Meadows, Inc; Vocomp-20.

2.12 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 or aromatic polyurea with a Type A shore durometer hardness range of 90 to 95 according to ASTM D 2240.

C. Bonding Agent: ASTM C 1059/C 1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types I and II at nonload bearing conditions, Types IV and V at load bearing conditions, for bonding hardened or freshly mixed concrete to hardened concrete.

E. Reglets: Fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

F. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.13 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

2.14 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete as indicated on drawings, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash: 25 percent.
2. Combined Fly Ash and Pozzolan: 25 percent.
3. Slag Cement: 50 percent.
4. Combined Fly Ash or Pozzolan and Slag Cement: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
5. Silica Fume: 10 percent.
6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
7. Combined Fly Ash or Pozzolans, Slag Cement, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to the following by percent by weight of cement:

1. Prestressed and Post-Tensioned concrete: 0.06
2. Reinforced concrete exposed to chloride: 0.15
3. Reinforced concrete that is not dry or protected from moisture: 0.30
4. Reinforced concrete that is dry or protected from moisture: 1.00

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a w/c ratio below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.15 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.16 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

1. Class A, 1/8 inch for smooth-formed finished surfaces.
2. Class B, 1/4 inch for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete, unless otherwise noted.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEM INSTALLATION

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3. Install dovetail anchor slots in concrete structures as indicated.

3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material are not acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 SHORING AND RESHORING INSTALLATION

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 VAPOR-RETARDER INSTALLATION

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder according to manufacturer's written instructions.

3.6 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded-wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

F. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

G. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material according to ASTM A 780/A 780M. Use galvanized-steel wire ties to fasten zinc-coated steel reinforcement.

3.7 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.

3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.8 WATERSTOP INSTALLATION

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

3.9 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers

of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

3.10 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.

C. Rubbed Finish: Apply the following to smooth-formed-finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix 1 part portland cement to 1-1/2 parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Scrub grout into voids and remove excess grout. When

grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix 1 part portland cement and 1 part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.11 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.

1. Apply scratch finish to surfaces to receive concrete floor toppings or mortar setting beds for bonded cementitious floor finishes.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces to receive trowel finish or to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:

a. Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15.

3. Finish and measure surface, so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

G. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregate finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:

1. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistive aggregate over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.
2. After broadcasting and tamping, apply float finish.
3. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate.

H. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces according to manufacturer's written instructions and as follows:

1. Uniformly apply dry-shake floor hardener at a rate of 100 lb/100 sq. ft. unless greater amount is recommended by manufacturer.
2. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
3. After final floating, apply a trowel finish. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

3.12 MISCELLANEOUS CONCRETE ITEM INSTALLATION

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 4 inches high unless otherwise indicated, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
3. Minimum Compressive Strength: 3000 psi at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.13 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.

    a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies does not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

    a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written

instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.14 LIQUID FLOOR TREATMENT APPLICATION

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than 28 days' old.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.15 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least six month(s). Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.16 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar matches surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and

mixture as original concrete, except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.17 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports in accordance with IBC – Chapter 17 and applicable referenced standards.

B. Inspections:

1. Steel reinforcement placement.
2. Steel reinforcement welding.
3. Headed bolts and studs.
4. Verification of use of required design mixture.
5. Concrete placement, including conveying and depositing.
6. Curing procedures and maintenance of curing temperature.
7. Verification of concrete strength before removal of shores and forms from beams and slabs.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

3. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C 231/C 231M, pressure method, for normal-weight concrete; ASTM C 173/C 173M, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
6. Unit Weight: ASTM C 567/C 567M, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compression Test Specimens: ASTM C 31/C 31M.

    a. Cast and laboratory cure a minimum of three sets of two standard cylinder specimens for each composite sample.
    b. Cast and field cure a minimum of three sets of two standard cylinder specimens for each composite sample.

8. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days. If 28 day tests do not meet specified compressive-strength requirements, hold remaining set of two laboratory-cured specimens for 56 day tests.

    a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days. If 28 day tests do not meet specified compressive-strength requirements, hold remaining set of two field-cured specimens for 56 day tests.
    b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
11. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and

materials, compressive breaking strength, and type of break for 7-, 28-, and 56-day tests.

12. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect as a correlation guide, but will not be used as sole basis for approval or rejection of concrete.
13. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
14. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
15. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

D. Measure floor and slab flatness and levelness according to ASTM E 1155 within 24 hours of finishing.

3.18 PROTECTION OF LIQUID FLOOR TREATMENTS

A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 03300

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Mortar and grout.
3. Masonry joint reinforcement.
4. Ties and anchors.
5. Embedded flashing.
6. Miscellaneous masonry accessories.

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement."

C. Samples for Verification:

1. Accessories embedded in masonry.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of the following:

1. Masonry units.
2. Cementitious materials. Include brand, type, and name of manufacturer.
3. Grout mixes. Include description of type and proportions of ingredients.
4. Joint reinforcement.
5. Anchors, ties, and metal accessories.

B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91 for air content.
2. Include test reports, according to ASTM C1019, for grout mixes required to comply with compressive strength requirement.

C. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.6 QUALITY ASSURANCE

A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

C. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver pre-blended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store pre-blended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of door frames, as well as similar products with painted and integral finishes, from mortar droppings.

D. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 UNIT MASONRY, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

2.2 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide bullnose units for outside corners unless otherwise indicated.

B. CMUs: ASTM C90.

1. Density Classification: Normal weight.
2. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
3. Unit Compressive Strength: Provide units with minimum net-area compressive strength of 1900 psi.

2.3 MASONRY LINTELS

A. General: Provide masonry lintels complying with the requirements below.

B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.4 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of Portland cement and hydrated lime containing no other ingredients.

D. Aggregate for Mortar: ASTM C144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No.16 sieve.

E. Aggregate for Grout: ASTM C404.

F. Water: Potable.

2.5 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Masonry Joint Reinforcement, General: ASTM A951/A951M.

1. Interior Walls: M11 galvanized, carbon steel.
2. Wire Size for Side Rods: 0.148-inch diameter.
3. Wire Size for Cross Rods: 0.148-inch diameter.
4. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
5. Provide in lengths of not less than 10 feet, with prefabricated corner and end units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods.

2.6 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A82/A82M; with ASTM A153/A153M, Class B-2 coating.
2. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

2.7 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene**,** urethane or PVC.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTMD2000, DesignationM2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D226, Type I (No.15 asphalt felt).

D. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from

0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
   b. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
   c. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.

2.8 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Diedrich Technologies, Inc.
      b. EaCo Chem, Inc.
      c. ProSoCo, Inc.

2.9 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

   1. Do not use calcium chloride in mortar or grout.
   2. Use Portland cement-lime mortar unless otherwise indicated.

B. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to required compressive strength of masonry.

   1. For reinforced masonry, use Type S.
   2. For exterior and interior load-bearing above grade masonry, use Type S.
   3. For interior non-load bearing partitions, and for other applications where another type is not indicated, use Type N.

C. Grout for Unit Masonry: Comply with ASTM C476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C476, Table1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2500 psi. Grout shall reach 70% compressive strength at 7-days.
3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C143/C143M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

1. Mix units from several pallets or cubes as they are placed.

F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.

3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, and remove loose masonry units and mortar.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

G. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

H. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Division 07 Section “Fire-Resistive Joint Systems”.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow brick and CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Tool exposed joints to match existing joints.

C. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.6 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.
2. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners**,** returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than 1 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.

2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.8 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one of the following methods:

1. Install preformed control-joint gaskets designed to fit standard sash block.
2. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
3. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

C. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than 3/8 inch.

3.9 LINTELS

A. Install steel lintels where indicated.

B. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.

C. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.10 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

END OF SECTION 042000

SECTION 051200 - STRUCTURAL STEEL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 REFERENCES

A. Details and fabrication of structural steel shall conform to the following publications.

B. AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

1. AISC M013 Detailing for Steel Construction

2. AISC M016 ASD Manual of Steel Construction

3. AISC S335 Structural Steel Buildings Allowable Stress Design and Plastic Design

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A36/A36M Carbon Structural Steel

2. ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

3. ASTM A123/A123M Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

4. ASTM A153/A153M Zinc Coating (Hot-Dip) on Iron and Steel Hardware

5. ASTM A325 Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

6. ASTM A500 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

7. ASTM A563 Carbon and Alloy Steel Nuts

8. ASTM A780 Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

9. ASTM A992/A992M Steel for Structural Shapes for Use in Building Framing

10. ASTM C827 Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures

11. ASTM C1107 Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

12. ASTM F436Hardened Steel Washers

13. ASTM F844 Washers, Steel, Plain (Flat), Unhardened for General Use

14. ASTM F959Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners

15. ASTM F1554 Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

D. AMERICAN WELDING SOCIETY, INC. (AWS)

1. AWS D1.1 Structural Welding Code – Steel

E. STEEL STRUCTURES PAINTING COUNCIL (SSPC)

1. SSPC SP 3 Power Tool Cleaning

2. SSPC SP 6 Commercial Blast Cleaning

3. SSPC Paint 25 Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)

4. SSPC PA 1 Shop, Field, and Maintenance Painting

1.3 SUMMARY

A. Section Includes:

1. Structural steel.

2. Architecturally exposed structural steel.

3. Grout.

B. Related Sections:

1. Division 1 Section "Quality Requirements" for independent testing agency procedures and administrative requirements.

2. Division 5 Section "Metal Fabrications" for steel lintels or shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and other metal items not defined as structural steel.

1.4 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges", that support design loads.

B. Architecturally Exposed Structural Steel: Structural steel designated as architecturally exposed structural steel in the Contract Documents.

1.5 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand ASD-service loads indicated and comply with other information and restrictions indicated.

1. Select and complete connections using schematic details indicated and AISC's "Manual of Steel Construction, Allowable Stress Design," Part 4.

2. Engineering Responsibility: Fabricator's responsibilities include using a qualified professional engineer to prepare structural analysis data for structural-steel connections.

B. Construction: Combined system of moment frame, braced frame, and shear walls.

C. Moment Connections: Type FR, fully restrained.

1.6 ACTION SUBMITTALS

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

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.

2. Include embedment drawings.

3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.

4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts.

5. For structural-steel connections indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Erection Plan.

1. Submit for record purposes. Indicate the sequence of erection, temporary shoring and bracing, and a detailed sequence of welding, including each welding procedure required.

D. Welding certificates.

E. Qualification Data: For testing agency.

F. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:

1. Structural steel including chemical and physical properties.

2. Bolts, nuts, and washers including mechanical properties and chemical analysis.

3. Shear stud connectors.

4. Load indicator washers.

5. Shop primers.

6. Nonshrink grout.

G. Source quality-control test reports.

1.7 QUALITY ASSURANCE

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

B. Fabricator Qualifications: Engage a firm experienced in fabricating structural steel similar to that indicated for this Project and with a record of successful in-service

performance, as well as sufficient production capacity to fabricate structural steel without delaying the Work.

1. Fabricator must participate in the AISC Quality Certification Program and be designated an AISC-Certified Plant as follows:

   a. Category: Category I, conventional steel structures.

C. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

D. Comply with applicable provisions of the following specifications and documents:

1. AISC's "Code of Standard Practice for Steel Buildings and Bridges."

2. AISC's "Seismic Provisions for Structural Steel Buildings" and "Supplement No. 2."

3. AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."

4. AISC's "Specification for the Design of Steel Hollow Structural Sections."

5. AISC's "Specification for Allowable Stress Design of Single-Angle Members."

6. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.

2. Clean and relubricate bolts and nuts that become dry or rusty before use.

3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

1.9 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992/A 992M, Grade 50.

B. Channels, Angles: ASTM A 36.

C. Plate and Bar: ASTM A 36.

D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.

E. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.

1. Weight Class: Standard.

2. Finish: Black**.**

F. Welding Electrodes and Rods: Comply with AWS D1.1 requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.

1. Finish: Plain**.**

B. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.

C. Unheaded Anchor Rods: ASTM F 1554, Grade 36.

1. Configuration: as indicated.

2. Nuts: ASTM A 563 hex carbon steel.

3. Plate Washers: ASTM A 36/A 36M carbon steel.

4. Washers: ASTM F 436 hardened carbon steel.

5. Finish: Plain.

D. Headed Anchor Rods: ASTM F 1554, Grade 36, straight.

1. Nuts: ASTM A 563 hex carbon steel.

2. Plate Washers: ASTM A 36/A 36M carbon steel.

3. Washers: ASTM F 436 hardened carbon steel.

4. Finish: Plain.

E. Load Indicator Washers: ASTM F959.

2.3 SHOP PRIMER

A. SSPC Paint 25 epoxy-polyamide, green primer (Form 150) type 1. Primer shall conform to Federal, State, and local VOC regulations. If flash rusting occurs, re-clean the surface prior to application of primer.

2.4 GALVANIZING

A. ASTM A123 or ASTM A153, as applicable, unless specified otherwise, galvanize after fabrication where practicable.

2.5 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time; capable of developing a minimum compressive strength of 8,000 psi in 28 days.

2.6 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."

1. Identify high-strength structural steel according to ASTM A 6/ A 6M and maintain markings until structural steel has been erected.

2. Mark and match-mark materials for field assembly.

3. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Architecturally Exposed Structural Steel: Comply with fabrication requirements, including tolerance limits, of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel identified as architecturally exposed structural steel.

1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale, seam marks, roller marks, rolled trade names, and roughness.

2. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.

C. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.

D. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

E. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

F. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 6 (U.N.O.)

G. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

H. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.

2. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.

3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.7 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened (U.N.O.).

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.

2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.

a. Grind butt welds flush.

b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

2.8 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Shop prime structural steel, except as modified herein, in accordance with SSPC PA 1. Do not prime steel surfaces embedded in concrete, galvanized surfaces, surfaces to receive sprayed-on fireproofing, surfaces to receive epoxy coatings, surfaces designed as part of a composite steel concrete section, or surfaces within 0.5 inch of the toe of the welds prior to welding, except surfaces

on which metal decking is to be welded. Prior to assembly, prime surfaces which will be concealed or inaccessible after assembly. Do not apply primer in foggy or rainy weather; when the ambient temperature is below 45 degrees F or over 95 degrees F; or when the primer may be exposed to temperatures below 40 degrees F within 48 hours after application, unless approved otherwise by the Engineer.

B. Surface Preparation: Clean surfaces to be painted. Prepare surfaces according to the following specifications and standards:

1. SSPC SP 6, except steel exposed in spaces above ceilings, attic spaces, furred spaces, and chases that will be hidden to view in finished construction may be cleaned to SSPC SP 3 when recommended by the shop primer manufacturer. Maintain steel surfaces free from rust, mill scale, spatter, slag, flux, dirt, oil, grease, and other contaminants through final assembly.

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 2 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces. Repair damaged primed surfaces with an additional coat of primer.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

2.9 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.

1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.

2. Galvanize lintels, shelf angles and welded door frames attached to structural-steel frame and located in exterior walls.

3. All structural steel, bolts, connectors and fasteners exposed to moisture shall be galvanized.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

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

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Base, Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.

2. Weld plate washers to top of baseplate.

3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.

4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure.

Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.

2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.

G. Do not use thermal cutting during erection.

H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened (U.N.O.).

A. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress

Design and Plastic Design" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.

2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.

3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.

   a. Grind butt welds flush.

   b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to inspect the erected steel in the field. This inspection shall also include alignment, position of member, welds and high-strength bolted connections, painting, etc. The inspection agency shall also submit to the Structural Engineer certified reports showing results of these inspections.

B. Bolted Connections: Shop-bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Field welds will be visually inspected according to AWS D1.1.

1. Should deficiencies in welds be noted by visual inspection then field welds may be tested according to AWS D1.1 and the following inspection procedures, at Owner's option:

   a. Liquid Penetrant Inspection: ASTM E 165.

   b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.

   c. Ultrasonic Inspection: ASTM E 164.

   d. Radiographic Inspection: ASTM E 94.

2. In addition to the visual inspection as indicated above, ultrasonic testing of all groove welds which are in tension and 25% of all groove welds which are in compression shall be required. The testing shall be done using "Branson" ultrasonic testing equipment, or other approved non-destructive testing systems.

If faulty welds are discovered by this testing, costs of repair and any additional tests shall be borne by the Contractor.

D. Should visual inspection identify deficiencies in welded shear connectors, then field-welded shear connectors may be tested according to requirements in AWS D1.1 for stud welding at Owner's option as follows:

1. Perform bend tests if visual inspections reveal either a less-than- continuous 360-degree flash or welding repairs to any shear connector.

2. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

E. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

F. Submit final certified inspection report letter signed and sealed by P.E. licensed in the state of Maryland, indicating that the steel, including corrected deficiencies as erected meets all of the requirements of the Contract Documents.

3.6 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.

B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories**,** bearing plates, and abutting structural steel where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Clean and prepare surfaces by SSPC-SP 3.

C. Touchup Painting: Cleaning and touchup painting are specified in Section 09911 "Exterior Painting" and Section 09912 "Interior Painting."

PART 4 - MEASUREMENT AND PAYMENT

4.1 METHOD OF MEASUREMENT

A. The materials and labor associated with this specification section shall be measured on a lump sum basis. Payment shall be based on estimated quantity of work performed. The price shall be full compensation for all work contained in the bid item as described herein

and required by the related Sections. Costs include all labor, materials, services, tools, equipment and incidentals necessary to complete the Work in every respect.

4.2 BASIS OF PAYMENT

A. Payment will be made under:

1. 8004 Structural Modifications [per lump sum].

END OF SECTION 051200

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SECTION 055000 – METAL FABRICATION

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section specifies miscellaneous metalwork, which consists of metal fabrication other than structural metal framing.

1.2 REFERENCES

A. Details and fabrication of metal fabrications shall conform to the following publications.

B. American Institute of Steel Construction (AISC)

1. AISC Manual of Steel Construction".

C. American National Standards Institute (ANSI)

1. ANSI A14.3 Ladders – Fixed – Safety Requirements

D. American Society of Mechanical Engineers (ASME)

1. ASME B18.2.1 Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)

2. ASME B18.6.1 Wood Screws (Inch Series)

3. ASME B18.6.3 Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series)

4. ASME 18.22.1 Plain Washers

E. ASTM International (ASTM)

1. ASTM A27 Standard Specification for Steel Castings, Carbon, for General Application

2. ASTM A36 Standard Specification for Carbon Structural Steel

3. ASTM A48 Standard Specification for Gray-Iron Castings

4. ASTM A47 Standard Specification for Ferritic Malleable Iron Castings

5. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

6. ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

7. ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

8. ASTM A283 Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

9. ASTM A307 Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength

10. ASTM A320 Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low Temperature Service

11. ASTM A489 Standard Specification for Carbon Steel Lifting Eyes

12. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

13. ASTM A563 Standard Specification for Carbon and Alloy Steel Nuts

14. ASTM A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

15. ASTM A1011 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability

16. ASTM B26 Standard Specification for Aluminum-Alloy Sand Castings

17. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

18. ASTM B210 Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes

19. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes

20. ASTM B632 Standard Specification for Aluminum-Alloy Rolled Tread Plate

21. ASTM B633 Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel

22. ASTM C1107 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

23. ASTM D1187 Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal

24. ASTM E488 Standard Test Methods for Strength of Anchors in Concrete Elements

25. ASTM F593 - 13 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

26. ASTM F594 Standard Specification for Stainless Steel Nuts

27. ASTM F1554 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

F. American Welding Society (AWS)

1. AWS D1.1 Structural Welding Code—Steel

2. AWS D1.2 Structural Welding Code—Aluminum

1.3 SUBMITTALS

A. Manufacturer's catalog data, including construction features, dimensional data, technical information, which define details of construction that demonstrate compliance with this specification.

B. Fabrication drawings and installation drawings that provide sufficient information including detailed dimensional information to fabricate and install all metal fabrications.

C. Shop drawings for metal stairs and landings shall be signed and sealed by a professional engineer licensed in the State of Maryland.

D. Submit design calculations for metal stairs and landings. Calculations shall be signed and sealed by a professional engineer licensed in the State of Maryland.

E. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."

2. AWS D1.2, "Structural Welding Code--Aluminum."

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.

2. Provide allowance for trimming and fitting at site.

1.6 COORDINATION

A. Coordinate installation of anchorages for metal fabrications. 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.

B. Coordinate installation of steel weld plates and angles for casting into concrete that are specified in this Section but required for work of another Section. Deliver such items to Project site in time for installation.

1.7 CONTRACTOR FURNISHED STAIR DESIGNS

A. The Contractor shall furnish designs for interior and exterior metal stairs, with associated landings, and guardrails.

B. Designs shall include all fasteners to concrete structures.

C. For exterior aluminum stairs, designs shall include foundation supports and concrete base slabs.

D. Stairs designs shall comply with all applicable OSHA regulations and prevailing building codes.

1.8 PERFORMANCE REQUIREMENTS

A. Structural Performance of Ladders: Provide ladders capable of withstanding the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

B. Thermal Movements: Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

PART 2 – PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 MATERIALS

A. Materials for miscellaneous metalwork shall be as specified in Table 1.

Table 1. Materials for Miscellaneous Metalwork

Material	Specification
Nonstructural steel bars, angles, clips, plates, shapes, and similar items	ASTM A36 or ASTM A283
Steel pipe	ASTM A 53, Schedule 40, unless another weight is indicated or required by structural loads
Iron castings	ASTM A48, Class 30, unless another class is indicated or

Table 1. Materials for Miscellaneous Metalwork

Material	Specification
	required by structural loads.
Structural steel tubing	ASTM A500, Grade B
Steel bolts (except flanges and anchor bolts)	ASTM A307, Grade A
Stainless steel	ASTM A320, Type 304, except where otherwise noted
Aluminum seamless tubes	ASTM B210
Aluminum bars, rods, wire, shapes and tubes, and other extrusions	ASTM B221, Alloy 6061-T6
Aluminum plate and sheet	ASTM B 209, Alloy 6061-T6
Aluminum-alloy rolled tread plate	ASTM B 632, Alloy 6061-T6
Aluminum Castings	ASTM B 26, Alloy 443.0-F

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts and, where indicated, flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group 1.

D. Anchor Bolts

1. Provide hot-dip galvanized anchor bolts, conforming to ASTM F1554, Grade 36, where item being fastened is indicated to be galvanized.

2. Provide ASTM F593 bolts and ASTM F594 nuts, Group 1, where stainless steel is indicated.

E. Eyebolts: ASTM A489.

F. Machine Screws: ASME B18.6.3.

G. Lag Bolts: ASME B18.2.1.

H. Wood Screws: Flat head, ASME B18.6.1.

I. Plain Washers: Round, ASME B18.22.1.

J. Lock Washers: Helical, spring type, ASME B18.21.1.

K. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

1. Alloy Group 1 stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594.

2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Shop Primers: Provide primers that comply with Division 09 painting Sections.

C. Zinc-Rich Primer: Complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.

1. Use primer with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

G. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 5,000 psi, unless otherwise indicated.

2.5 FABRICATION

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work true to line and level with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts, unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

J. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Whenever needed, because of the thickness of the metal, holes shall be subpunched and reamed or shall be drilled.

K. Fabrication including cutting, drilling, punching, threading and tapping required for miscellaneous metal or adjacent work shall be performed prior to hot-dip galvanizing.

L. Iron Castings: Castings shall be as specified on the drawings. Castings weighing less than 100 pounds shall be hot-dip galvanized after machining. Castings weighing greater than 100 pounds shall be galvanized where specified.

M. Cover Plates: Cover plates (Checkered Plate) shall be Alcoa C 102 aluminum tread plate, Reynolds diamond tread plate, or approved equal. No single piece of floor and cover plate shall weigh more than 80 pounds unless specifically detailed otherwise.

N. Ladders: Unless otherwise specified, ladders shall be of all aluminum construction.

O. Safety Stair Nosings: Safety stair nosings shall be 4 inches wide and shall be Alumogrit, Type 101 as manufactured by Wooster Products, Incorporated, Alumalum Style A as manufactured by American Abrasive Metals Company, Style AX as manufactured by Safe T Metal Company, Inc., or approved equal.

P. Other Miscellaneous Steel Metalwork: Other miscellaneous steel metalwork including embedded and nonembedded steel metalwork, hangers and inserts shall be as specified on the drawings and shall be hot-dip galvanized after fabrication.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work. Items include but not limited to the following:

1. Steel framing and supports for overhead doors.

2. Steel framing and supports for mechanical and electrical equipment.

3. Steel framing and supports for applications where framing and supports are not specified in other Sections.

4. Miscellaneous steel trim including steel angle corner guards, steel edgings and loading-dock edge angles.

5. Metal Bollards.

B. Fabricate units from steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.

1. Fabricate units from slotted channel framing where indicated.

2. Furnish inserts if units are installed after concrete is placed.

C. Galvanize miscellaneous framing and supports.

D. Prime miscellaneous framing and supports with zinc-rich primer.

2.7 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches, unless otherwise indicated.

C. Galvanize loose steel lintels located in exterior walls.

D. Prime loose steel lintels located in exterior walls with zinc-rich primer.

2.8 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.

1. Provide mitered and welded units at corners.

2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize shelf angles located in exterior walls.

D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.9 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize plates after fabrication.

2.10 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with not less than two integrally welded steel strap anchors for embedding in concrete.

2.11 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize exterior miscellaneous steel trim and interior miscellaneous steel trim, where indicated.

2.12 METAL LADDERS

A. General:

1. Comply with ANSI A14.3, unless otherwise indicated.

2. Space siderails 18 inches apart, unless otherwise indicated.

3. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted brackets, made from same metal as ladder.

B. Aluminum Ladders:

1. Side rails: Continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches deep, 3/4 inch wide, and 1/8 inch thick.

2. Rungs: Extruded-aluminum tubes, not less than 3/4 inch deep and not less than 1/8 inch thick, with ribbed tread surfaces.

3. Fit rungs in centerline of side rails; fasten by welding or with stainless-steel fasteners or brackets and aluminum rivets.

2.13 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

2.14 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:

1. ASTM A 123, for galvanizing steel and iron products.

2. ASTM A 153, for galvanizing steel and iron hardware.

B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:

1. Exteriors (SSPC Zone 1B) and Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."

C. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.15 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General:

1. Fieldwork shall not be permitted on galvanized items. Drilling of bolts or enlargement of holes to correct misalignment will not be allowed.

2. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Whenever needed, because of the thickness of the metal, holes shall be subpunched and reamed or shall be drilled. Cutting, drilling, punching, threading and tapping shall be performed prior to hot dip galvanizing.

3. Dissimilar metals shall be protected from galvanic corrosion by means of pressure tapes, coatings or isolators.

4. Metalwork to be embedded in concrete shall be placed accurately and held in correct position while the concrete is placed or, if specified, recesses or

blockouts shall be formed in the concrete. The surfaces of metalwork in contact with or embedded in concrete shall be thoroughly cleaned. If accepted, recesses may be neatly cored in the concrete after it has attained its design strength and the metalwork grouted in place.

B. Seat Angles, Supports and Guides: Seat angles for grating and supports for floor plates shall be set so that they are flush with the floor and also maintain the grating and floor plates flush with the floor.

C. Cover Plates: Cover plates shall be field measured for proper cutouts and proper sizes.

D. Ladders: Ladders shall be fitted accurately and field measured where necessary.

E. Safety Stair Nosings: Unless otherwise specified, safety stair nosings shall be installed on all concrete stairs. Nosings shall be secured to concrete with suitable anchors at 15 inches on centers and not more than 4 inches from the ends. Rubber tape, 1/8 inch thick, shall be provided at both ends and cut to fit shape of tread prior to concrete placement.

F. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

G. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

H. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

I. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.

J. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

K. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for operable partitions securely to and rigidly brace from building structure.

C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.

1. Grout baseplates of columns supporting steel girders after girders are installed and leveled

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780.

END OF SECTION 055000

METAL GRATING – SECTION 055300

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section specifies floor grating and grating stair treads. Unless otherwise indicated on Drawings, floor grating and stair grating treads shall be galvanized steel. Steel grating shall only be used where indicated on the Drawings.

1.2 QUALITY ASSURANCE

A. Metal grating shall conform to the following publications.

B. NAAMM (National Association of Architectural Metal Manufacturers)

1. NAAMM MBG 531—Metal Bar Grating Manual.

2. Shop NAAMM MBG 532—Heavy Duty Metal Bar Grating Manual.

C. ASTM:

1. ASTM A36—"Standard Specification for Carbon Structural Steel."

1.3 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 21:

1. Catalog data which demonstrate compliance with this specification.

2. Shop drawings that show complete dimensional information, details of construction, anchor detail and installation details. Dimensions shall be based on actual field dimensions to assure proper fit.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Steel Grating:

1. Steel grating bearing bars and cross bars shall be of welding quality mild carbon steel conforming to ASTM A1011. Cross bars shall be

electroforge welded to bearing bars at 4 inches maximum. Bearing bar top surface shall be serrated. Grating sections shall be hot dipped galvanized after fabrication.

2. Grating shall be able to carry a uniform load of 100 pounds per square foot with a deflection not exceeding 1/4 inch. Bearing bar size shall not be less than indicated on the drawings.

2.2 FABRICATION

A. General:

1. Both bearing bars and cross bars shall be continuous.

2. All grating shall be end banded with bars the same thickness of the bearing bars except at I-bar bearing bars where the thickness shall be 1/8 inch minimum. End banding shall be the height of the bearing bar minus 1/4 inch with the top of the end banding level with the top of the bearing bars. At heavy duty grating, the end banding shall be welded to every bearing bar. At non-heavy duty grating, the end banding may be welded to alternate bearing bars so as not exceed a spacing of 5 inches.

3. Rough weld beads and sharp metal edges on gratings shall be ground smooth. Welds exposed to view shall be uniform and neat. Welds to be galvanized shall be sandblasted prior to galvanizing.

4. Grating shall bear a minimum of 1 inch on supports except for heavy duty steel grating which shall bear a minimum of 2 inches on supports.

5. No single piece of grating shall weigh more than 80 pounds unless specifically detailed otherwise.

6. Cutouts for circular obstructions shall be 2 inches minimum, 3 inches maximum, larger in diameter than obstruction. All openings shall be banded with bars having the same dimensions as the bearing bars except where only one bearing bar is cut. Bar shall be welded to each bearing bar cut at opening. Cutouts shall not cut more than 40% of the bearing bars in a grating panel.

7. Each section of grating shall be anchored to supports with a minimum of four anchors, two per end, approximately 6 inches from each side. All anchoring systems shall not protrude above the top of the grating except for saddle clips. Anchoring by welding shall not be acceptable. Anchors

for other bar type gratings shall be with 316 stainless steel saddle clips. Anchors for aluminum plank grating shall be of aluminum construction made specifically for such grating. Bolts utilized in all anchors shall be minimum 1/4-inch diameter, 316 stainless steel.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General:

1. Installation shall be in accordance with shop drawings and NAAMM 531 and NAAMM 532, as applicable and the additional items in this section.

2. Fieldwork shall not be permitted on galvanized items. Drilling of bolts or enlargement of holes to correct misalignment will not be allowed.

3. Dissimilar metals shall be protected from galvanic corrosion by means of pressure tapes, coatings or isolators. Aluminum in contact with concrete shall be protected by a coat of bituminous paint.

4. Metalwork to be embedded in concrete shall be placed accurately and held in correct position while the concrete is placed or, if specified, recesses or blockouts shall be formed in the concrete after it has attained its design strength and the metalwork grouted in place. The surfaces of metalwork in contact with or embedded in concrete shall be thoroughly cleaned, and if of aluminum construction, coated with bituminous paint.

5. Grating shall be field measured for proper cutouts and proper sizes.

6. Install such that no gap exceeds 1/2 inch.

3.2 CLEANING

A. After installation, damaged surfaces of shop primed metals shall be cleaned and touched up with the same material used for the shop coat. Damaged surfaces of galvanized metals shall be repaired.

END OF SECTION 055300

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SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Wood blocking and nailers.
2. Plywood backing panels.

1.3 DEFINITIONS

A. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NLGA - National Lumber Grades Authority.
2. SPIB - Southern Pine Inspection Bureau.
3. WCLIB - West Coast Lumber Inspection Bureau.
4. WWPA - Western Wood Products Association.

1.4 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, net amount of preservative retained, and chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
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, both before and after exposure to elevated temperatures when tested according to ASTM D 5516 and ASTM D 5664.
3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

4. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

B. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:

1. Preservative-treated wood.
2. Fire-retardant-treated wood.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber, plywood, and other panels; place spacers between each bundle to provide air circulation. 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 lumber grading agencies certified by the American Lumber Standards Committee Board of Review.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
3. Provide dressed lumber, S4S, unless otherwise indicated.
4. Provide dry lumber with 19 percent maximum moisture content at time of dressing for 2-inch nominal thickness or less, unless otherwise indicated.

B. Wood Structural Panels:

1. Plywood: Either DOC PS 1 or DOC PS 2, unless otherwise indicated.
2. Thickness: As needed to comply with requirements specified but not less than thickness indicated.
3. Factory mark panels according to indicated standard.

2.2 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, provide materials that comply with performance requirements in AWPA C20 (lumber) and AWPA C27 (plywood). Identify fire-retardant-treated wood with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.

1. Use treatment for which chemical manufacturer publishes physical properties of treated wood after exposure to elevated temperatures, when tested by a qualified independent testing agency according to ASTM D 5664, for lumber and ASTM D 5516, for plywood.
2. Use treatment that does not promote corrosion of metal fasteners.
3. Use Exterior type for exterior locations and where indicated.
4. Use Interior Type A High Temperature (HT), unless otherwise indicated.

2.3 MISCELLANEOUS LUMBER

A. General: Provide lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Furring.
4. Grounds.

B. For items of dimension lumber size, provide Construction, Stud, or No. 2 grade lumber with 19 percent maximum moisture content and any of the following species:

1. Mixed southern pine; SPIB.
2. Hem-fir or Hem-fir (north); NLGA, WCLIB, or WWPA.

C. For concealed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:

1. Mixed southern pine, No. 2 grade; SPIB.
2. Hem-fir or Hem-fir (north), Construction or 2 Common grade; NLGA, WCLIB, or WWPA.

2.4 PANEL PRODUCTS

A. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2 inch thick.

2.5 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, or in area of high relative humidity, and all preservative treated and fire retardant treated wood, provide

fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M, or of Type 304 stainless steel.

B. Nails, Wire, Brads, and Staples: FS FF-N-105.

C. Power-Driven Fasteners: CABO NER-272.

D. Wood Screws: ASME B18.6.1.

E. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

F. Lag Bolts: ASME B18.2.1.

G. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.

H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

1. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Discard units of material with defects that impair quality of carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.

B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

C. Apply field treatment complying with AWPA M4 to cut surfaces of preservative-treated lumber and plywood.

D. Securely attach carpentry work as indicated and according to applicable codes and recognized standards.

E. Countersink fastener heads on exposed carpentry work and fill holes with wood filler.

F. Use fasteners of appropriate type and length. Pre-drill members when necessary to avoid splitting wood.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION

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 PANEL PRODUCT INSTALLATION

A. Wood Structural Panels: Comply with applicable recommendations contained in APA Form No. E30K, "APA Design/Construction Guide: Residential & Commercial," for types of structural - use panels and applications indicated.

END OF SECTION 061000

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SECTION 071113 – BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cold-applied asphalt dampproofing for precast electric manholes.

1.3 SUBMITTALS

A. Product Data: For each type of product.

1.4 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit dampproofing to be performed according to manufacturers' written instructions.

B. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has cured.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Source Limitations: Obtain primary dampproofing materials and primers from single source from single manufacturer. Provide auxiliary materials recommended in writing by manufacturer of primary materials.

B. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction unless otherwise required.

2.2 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Trowel Coats: ASTM D 1227, Type II, Class 1.

B. Fibered Brush and Spray Coats: ASTM D 1227, Type II, Class 1.

C. Brush and Spray Coats: ASTM D 1227, Type III, Class 1.

D. VOC Content: 30 g/L or less.

E. Low-Emitting Materials: Dampproofing shall comply with the testing and product requirements of the Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 AUXILIARY MATERIALS

A. General: Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.

B. Cut-Back-Asphalt Primer: ASTM D 41.

C. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.

D. Asphalt-Coated Glass Fabric: ASTM D 1668, Type I.

E. Patching Compound of type recommended in writing by dampproofing manufacturer.

F. Protection Course: Extruded-polystyrene board insulation, unfaced, ASTM C 578, Type X, 1/2 inch thick.

G. Protection Course: Smooth-surfaced roll roofing complying with ASTM D 6380, Class S, Type III.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions with Applicator present, for compliance with requirements for surface smoothness, surface moisture, and other conditions affecting

performance of bituminous dampproofing work.

1. Test for surface moisture according to ASTM D 4263.

B. Proceed with application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.

B. Clean substrates of projections and substances detrimental to the dampproofing work; fill voids, seal joints, and remove bond breakers if any, as recommended in writing by prime material manufacturer.

C. Apply patching compound to patch and fill tie holes, honeycombs, reveals, and other imperfections.

3.3 APPLICATION, GENERAL

A. Comply with manufacturer's written instructions for dampproofing application, cure time between coats, and drying time before backfilling unless more stringent requirements are indicated.

1. Apply dampproofing to provide continuous plane of protection.
2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.

3.4 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Concrete Manholes: Apply two brush or spray coats at not less than 2 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat. The final thickness of dampproofing shall be 60 mils thick.

3.5 INSTALLATION OF PROTECTION COURSE

A. Where indicated, install protection course over completed-and-cured dampproofing. Comply with dampproofing-material and protection-course manufacturers' written

instructions for attaching protection course.

1. Support protection course over cured coating with spot application of adhesive type recommended in writing by protection-board manufacturer.

3.6 CLEANING

A. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 07113

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

1.4 CLOSEOUT SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.

1) UL in its "Fire Resistance Directory."

2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.

D. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E 84.

E. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those

components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

C. Install forming 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.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

D. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
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 the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.2 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E 2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

END OF SECTION 078413

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SECTION 078446 - FIRE-RESISTIVE JOINT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Joints in or between fire-resistance-rated constructions.
2. Joints in smoke barriers.

1.3 SUBMITTALS

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

B. Qualification Data: For qualified Installer.

C. Installer Certificates: From Installer indicating fire-resistive joint systems have been installed in compliance with requirements and manufacturer's written recommendations.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fire-resistive joint systems.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A firm experienced in installing fire-resistive joint systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its fire-resistive joint system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

B. Fire-Test-Response Characteristics: Fire-resistive joint systems shall comply with the following requirements:

1. Fire-resistive joint system tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Fire-resistive joint systems are identical to those tested per testing standard referenced in "Fire-Resistive Joint Systems" Article. Provide rated systems complying with the following requirements:

    a. Fire-resistive joint system products bear classification marking of qualified testing agency.
    b. Fire-resistive joint systems correspond to those indicated by reference to designations listed by the following:

        1) UL in its "Fire Resistance Directory."

C. Preinstallation Conference: Conduct conference at Project site.

1.5 PROJECT CONDITIONS

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

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

1.6 COORDINATION

A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.

B. Coordinate sizing of joints to accommodate fire-resistive joint systems.

C. Notify Owner's testing agency at least seven days in advance of fire-resistive joint system installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 FIRE-RESISTIVE JOINT SYSTEMS

A. Where required, provide fire-resistive joint 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 assemblies in or between

which fire-resistive joint systems are installed. Fire-resistive joint 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 fire-resistive joint systems with ratings determined per ASTM E 1966 or UL 2079:

1. Joints include those installed in or between fire-resistance-rated walls, floor or floor/ceiling assemblies, and roofs or roof/ceiling assemblies.
2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. A/D Fire Protection Systems Inc.
    b. Grace Construction Products.
    c. Hilti, Inc.
    d. Nelson Firestop Products.
    e. NUCO Inc.
    f. Specified Technologies Inc.
    g. 3M Fire Protection Products.
    h. Tremco, Inc.; Tremco Fire Protection Systems Group.
    i. USG Corporation.

C. Joints in Smoke Barriers: Provide fire-resistive joint systems with ratings determined per UL 2079.

1. L-Rating: Not exceeding 5.0 cfm/ft of joint at 0.30 inch wg at both ambient and elevated temperatures.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. A/D Fire Protection Systems Inc.
    b. Grace Construction Products.
    c. Hilti, Inc.
    d. Nelson Firestop Products.
    e. NUCO Inc.
    f. Specified Technologies Inc.
    g. 3M Fire Protection Products.
    h. Tremco, Inc.; Tremco Fire Protection Systems Group.
    i. USG Corporation.

D. Exposed Fire-Resistive Joint Systems: 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 of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing agency for systems 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: Clean joints immediately before installing fire-resistive joint systems 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 fill materials.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. 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 fire-resistive joint 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 fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates.

3.3 INSTALLATION

A. General: Install fire-resistive joint 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 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 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 fill materials for fire-resistive joint systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
2. Apply fill materials so they contact and adhere to substrates formed by joints.
3. For 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. Identify fire-resistive joint systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels will be visible to anyone seeking to remove or penetrate joint 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 - Fire-Resistive Joint System - 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.

B. Wall Identification: Permanently label walls containing fire-resistive joint systems with the words “FIRE AND/OR SMOKE BARRIER – PROTECT ALL OPENINGS”, using lettering not less than 3 inches high and with minimum 0.375-inch strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.

3.5 FIELD QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Where deficiencies are found or fire-resistive joint systems are damaged or removed due to testing, repair or replace fire-resistive joint systems so they comply with requirements.

C. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTING

A. Clean off excess fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint 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 fire-resistive joint 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 fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

END OF SECTION 078446

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Related Documents: Conditions of the Contract, Division 1 - General Requirements, and Drawings apply to Work of this Section.

B. Section Includes:

1. Preparing sealant substrate surfaces.
2. Sealants, caulking, and backing.
3. Accessories.
4. Preparing and installing all materials required where joint sealers are not specifically described in other Sections of Specifications.

C. Related Sections:

1. Section 092900 – Gypsum Board

1.2 DEFINITIONS

A. Sealants: Used for exterior joints subject to movement and which must exhibit weather resistance.

B. Caulking: Used for interior static joints, usually painted over.

1.3 SUBMITTALS

A. Submittals: Under provisions of Section 013300.

B. Product Data: Submit manufacturer's descriptive literature indicating sealant chemical characteristics, performance criteria, limitations, color availability, and related accessories.

C. Samples: Submit actual physical samples, 12 inches long x joint width, illustrating colors selected.

D. Quality Assurance Submittals:

1. Test Reports: Submit results of adhesion tests specified in this Section.
2. Certificates: Submit from manufacturer stating that products meet or exceed specified requirements and that products assembled for each joint are compatible with each other and with joint substrates.

3. Qualification Data: Submit applicator qualifications verifying years of experience; include list of completed projects having similar scope of work identified by name, location, date, reference name and phone number.
4. Manufacturer's Installation Instructions: Provide detailed instructions for construction including preparation, handling, and environmental requirements. Include priming requirements and joint size ratios.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Applicator Qualifications: Company specializing in applying sealants and caulking with minimum 5 years documented experience.

B. Testing:

1. Perform adhesion tests in accordance with ASTM C794 noting any modifications to this test procedure where compatibility is an issue.
2. Perform testing on interior and exterior sealants to determine if sealants or primers will stain adjacent surfaces, or be stained by adjacent materials. No sealant work shall start until results of these tests have been submitted to the Architect and written approval has been issued.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Do not install solvent curing sealants in enclosed building spaces.

B. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

C. When ambient temperature is 50^{o}F. or below, store foam seals at room temperature for at least 24 hours prior to installation.

1.6 WARRANTY

A. Provide five (5) year warranty under provisions of Section 017700.

B. Warranty: Include coverage of installed sealants and accessories which fail to achieve air tight and watertight seal, exhibit loss of adhesion or cohesion, or do not cure.

1.7 EXTRA STOCK MATERIALS

A. Provide five extra tubes of each color and type of sealant. Store on job site where directed by Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

1. Dow Corning Corp., Midland, MI.
2. General Electric Silicone Products Division, Waterford, NY.
3. Mameco International, Cleveland, OH.
4. Pecora Corp., Harleysville, PA.
5. Sonneborn Building Products Div. of Rexnord Chemical, Minneapolis, MN.
6. Tremco Corp., Cleveland, OH.

2.2 MATERIALS

A. Polyurethane Sealants:

1. Type JS1: One-part, moisture curing urethane conforming to ASTM C920, Type S, Grade NS, Class 25, Uses NT, M, A, and, as applicable to joint substrates indicated, O; 25% extension and compression movement capability.
2. Type JS2: One-part, moisture curing urethane conforming to ASTM C920, Type S, Grade P, Class 25, Uses T,M,A, and as applicable to joint substrates indicated, O; 25% extension and compression movement capability.

B. Acrylic Sealants:

1. Type JS3: One-part acrylic emulsion sealant, non-sag, mildew resistant, complying with ASTM C834, formulated to be paintable; 5% extension and compression movement capability.

C. Butyl Sealants:

1. Type JS4: One-part butyl rubber based acoustical sealant, non-drying, non-hardening, non-skinning, non-bleeding, permanently flexible sealant.

D. Colors: Custom colors to match adjacent materials, as selected by Architect.

E. Substitutions: Under provisions of Section 016000.

2.3 ACCESSORIES

A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Backer Rod: ANSI/ASTM D1056; D1565; round, non-gassing, closed-cell polyurethane foam rod; oversized 30 to 50 percent larger than joint width.

D. Bond Breaker Tape: Polyethylene tape or other plastic tape as recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

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

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine work and proceed under provisions of Section 014000.

B. Verify that surfaces are ready to receive work and field measurements are as shown on Drawings and recommended by the manufacturer.

C. Verify adhesion of sealants prior to start of project.

D. Beginning of installation means installer accepts existing surfaces.

E. Joints must be properly sized for expected movement and for type of sealant to be installed.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with recommendations of joint sealant manufacturer 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 concrete, masonry, unglazed surfaces of ceramic tile, and similar porous joint substrate surfaces by brushing, grinding, blast cleaning, 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 from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
3. Remove laitance and form release agents from concrete.
4. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile, and other nonporous 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 indicated or where recommended by joint sealant manufacturer based on preconstruction joint sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's recommendations. 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 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.

D. Verify that joint backing and release tapes are compatible with sealant.

E. Perform preparation in accordance with ASTM C804 for solvent release, C790 for latex base sealants.

F. Protect elements surrounding the work of this Section from damage or disfiguration.

3.3 INSTALLATION

A. General: Comply with joint sealant manufacturer's printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Acoustical Sealant Application Standard: Comply with recommendations of ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.

D. Installation of Sealant Backings: Install sealant backings to comply with the following requirements:

1. Install joint fillers of type indicated to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

   a. Do not leave gaps between ends of joint fillers.
   b. Do not stretch, twist, puncture, or tear joint fillers.
   c. Remove absorbent joint fillers that have become wet prior to sealant application and replace with dry material.

2. Install bond breaker tape between sealants where backer rods are not used between sealants and joint fillers or back of joints.

E. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Install sealants at the same time sealant backings are installed.

1. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges. Apply sealant within stated shelf life.
2. Install sealant free of air pockets, foreign embedded matter, ridges, and sags. Make sure sealant has good contact with joint faces.

F. Tooling of Non-sag Sealants: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

1. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

   a. Use masking tape to protect adjacent surfaces of recessed tooled joints.

3.4 CLEANING AND REPAIRING

A. Clean work under provisions of Section 017300.

B. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

C. Repair or replace defaced or disfigured finishes caused by work of this Section.

3.5 PROTECTION OF FINISHED WORK

A. Protect finished installation under provisions of Section 017300.

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

C. Provide protective covering and barriers for on-grade horizontal sealant joints. Protect from traffic and environmental dirt and debris until completely cured.

3.6 SCHEDULE

A. The following is a list of principal areas. Final color selection is subject to Architect approval.

B. Interior Joints:

1. Expansion and Control Joints: JS1; custom color to match adjacent materials.

    a. Trim or finish joints subject to minimal movement: JS3; custom color to match adjacent materials.

2. Expansion joints in horizontal traffic surfaces: JS2; custom color to match adjacent materials.
3. Concealed applications requiring acoustical seal: JS4; Black.

END OF SECTION 07920

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SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Non-Rated standard hollow metal doors and frames.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings.

B. Standard Hollow Metal Work: Hollow metalwork fabricated according to ANSI/SDI A250.8.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, and finishes.

B. Shop Drawings: Include the following:

1. Elevations of each door design.
2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.
8. Details of moldings, removable stops, and glazing.
9. Details of conduit and preparations for power, signal, and control systems.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metalwork from single source from single manufacturer.Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

B. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metalwork palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow metalwork under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch high wood blocking. Do not store in a manner that traps excess humidity.

1. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.8 COORDINATION

A. Coordinate installation of anchorages 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Amweld Building Products, LLC.
2. Ceco Door Products.
3. Curries Company.
4. National Custom Hollow Metal.
5. Fleming Door Products Ltd.
6. Pioneer Industries, Inc.
7. Steelcraft; an Ingersoll-Rand company.

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.

D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Powder-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.

G. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.

H. 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.

I. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 STANDARD HOLLOW METAL DOORS

A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.

1. Design: Flush panel, as indicated.
2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.
3. Vertical Edges for Single-Acting Doors: Manufacturer's standard.
    a. Beveled Edge: 1/8 inch in 2 inches.
4. Top and Bottom Edges: Closed with flush or inverted 0.042 inch thick, end closures or channels of same material as face sheets.
5. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

B. Interior Doors: Face sheets fabricated from cold-rolled steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

1. Level 2 and Physical Performance Level B (Heavy Duty), Model 2 (Seamless).

C. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

D. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.4 STANDARD HOLLOW METAL FRAMES

A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.

B. Interior Frames: Fabricated from cold-rolled steel sheet.

1. Fabricate frames with mitered or coped corners.
2. Fabricate frames as full profile welded unless otherwise indicated.
3. Fabricate knocked-down frames where existing frames are being replaced in existing concrete or masonry openings.
4. Frames for Level 2 Steel Doors: 0.053 inch thick steel sheet.
5. Frames for Borrowed Lights: Same as adjacent door frame.

C. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.

B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch thick, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2.6 STOPS AND MOLDINGS

A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed.

B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch high unless otherwise indicated.

C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch thick, fabricated from same material as frames in which they are installed.

2.7 FABRICATION

A. Fabricate hollow metalwork to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Tolerances: Fabricate hollow metalwork to tolerances indicated in SDI 117.

C. Hollow Metal Doors:

1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
2. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.

D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
4. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
5. Jamb Anchors: Provide number and spacing of anchors as follows:

    a. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

        1) Three anchors per jamb up to 60 inches high.
        2) Four anchors per jamb from 60 to 90 inches high.
        3) Five anchors per jamb from 90 to 96 inches high.
        4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
        5) Two anchors per head for frames above 42 inches wide and mounted in metal-stud partitions.

6. Door Silencers: Except on weather-stripped doors, 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.

E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.

F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 8 Section "Door Hardware."

1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metalwork for hardware.
4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

2.8 STEEL FINISHES

A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install hollow metalwork plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.

1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

    a. At fire-protection-rated openings, install frames according to NFPA 80.
    b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    c. Install frames with removable glazing stops located on secure side of opening.
    d. Install door silencers in frames before grouting.
    e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
    f. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
    g. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.

    a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
4. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

5. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.
6. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Standard Steel Doors:

    a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
    b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
    c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
    d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metalwork that is warped, bowed, or otherwise unacceptable.

B. 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.

END OF SECTION 081113

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SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and deliver finish hardware as listed, specified and required.

B. Related Work Specified elsewhere:

1. Steel Doors and Frames-Division 8.

1.2 SUBMITTALS

A. Hardware Schedule: Final hardware schedule shall be submitted in the manner indicated below. Coordinate hardware with doors, frames and related work to insure proper size, thickness, hand, function and finish of hardware. The schedule is to be in a vertical form, organized into "hardware sets" indicating complete designations of every item required for each door or opening. Include the following information:

1. Type, style, function, size and finish of each hardware item.
2. Name and manufacturer of each item.
3. Fastenings and other pertinent information.

    a. Location of hardware set cross referenced to indications on drawings both on floor plans and in door and frame schedule
    b. Explanation of all abbreviations symbols and codes contained in schedule

4. Mounting locations for hardware.
5. Door and frame sizes and materials.
6. Keying schedule.

B. Product Data: Product data shall be provided, in the form of, manufacturer's technical product fact sheets for each item of hardware. Include whatever information may be installation and for maintenance of operating parts and finish.

C. Samples: Samples shall be provided as requested by the University or architect. Each sample shall be returned to the finish hardware supplier when construction is completed.

D. Templates: Templates of finish hardware items to be supplied are to be furnished to each fabricator of doors, frames and other work to be factory prepared for the installation of hardware.

E. Keying Schedule: A keying schedule shall be submitted using keyset symbols referenced in DHI manual "Keying Systems And Nomenclature". The keying schedule shall be indexed by door number, keyset, hardware heading number, cross keying instructions and special key stamping instructions.

F. Wiring Diagrams: Coordinate installation of the electronic hardware with the project electrical engineer and provide installation and technical data, including wiring diagrams, to the project electrical engineer and electrical sub contractor. Upon completion of the electrical hardware installation, verify that all components are working properly and state in the required guarantee that this inspection has been performed.

G. Operations and maintenance data: At the completion of the job, furnish to the University two copies of an Owners Operation and Maintenance Manual. The manual shall consist of a labeled hardcover three ring binder with the following technical information:

1. Maintenance instructions for each item of hardware.
2. Catalog pages for each product.
3. Parts list for each product.
4. Copy of final hardware schedule.
5. Copy of final keying schedule.

1.3 QUALITY ASSURANCE

A. Supplier Qualifications: Suppliers shall be recognized architectural finish hardware suppliers, with warehousing facilities, who have been furnishing hardware in the projects vicinity for a period of not less than 2 years and who is or employs a DHI Certified A.H.C., who is available at reasonable times during the course of the work for consultation about products hardware requirements, to University, architect and contractor.

B. Fire-rated openings: Fire-rated openings shall be provided with fire-rated hardware in compliance with NFPA Standard No. 80 and local building code requirements. Provide only hardware tested and listed by U/L, for types and sizes of doors required and complies with requirements of door and frame labels.

C. To ensure and validate the proper closing, latching, sealing and securing of a door the manufacturer of gasketing shall provide a program of Field Quality Assurance. The program shall be acceptable to the architect and provide the site superintendent and installers with knowledge as to the industry acceptable standards for tolerances in manufacturing and field installation. The program shall create an audit trail of documentation for the inspection of pre-machined doors for machining and sizing, including hinge backset and depth of mortise, width and height. An “Installation Checklist” guideline shall also be furnished for verification of acceptability of related door, frame and hardware components prior to installing gasketing. These forms shall be

part of the submittal process and shall be acknowledged by the site supervisor and returned to the manufacturer on a timely basis.

1.4 DELIVERY, STORAGE AND HANDLING

A. Marking and Packaging: Mark each item or package separately, with identification related to hardware set number, door number and keyset symbol.

B. Delivery:

1. Deliver individually packaged and properly marked finish hardware at the proper time and location to avoid any delays in construction or installation.
2. At time of delivery, inventory hardware jointly with representatives of hardware supplier and hardware installer until each is satisfied that count is correct.

C. Storage:

1. A secure, dry lock up with strong and sufficient shelving shall be provided for hardware delivered to the project, to protect the material and the finishes.
2. Control handling and installation of hardware items, which are not immediately replaceable, so that completion of the work will not be delayed by hardware losses, both before and after installation.

1.5 WARRANTY

A. All finish hardware products shall be covered by a 2-year factory warranty against defects in material and workmanship from the date of substantial completion of the project.

B. Supply warranty verification to the University for products that provide factory warranties for periods longer than one year. Locksets and exit devices shall have a 3-year factory warranty, door closers a 10-year factory warranty.

1.6 MAINTENANCE

A. Extra Materials:

1. Furnish 3-dozen extra screws and other fasteners of each size, type, and finish used with the hardware items provided. These screws and fasteners are to be delivered to the hardware installer for use during installation. All extra screws and fasteners and all special installation tools furnished with the hardware shall be turned over to the University at the completion of the job.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. List of manufacturers represented in this section:

1. Door Hardware Systems Inc. – 800-836-8085 – www.dhsi-seal.com
2. Horton Automatics – 800-266-2474 – www.hortondoors.com
3. H.B. Ives – 877-613-8766 – www.iveshardware.com
4. LCN 800-526-2400 – www.lcnclosers.com
5. Locknetics – 866-322-1233 – www.locknetics.com
6. Security Door Controls – 805-494-0622 – www.sdcsecurity.com
7. Sedco Switches – 800-842-2545 – www.sedco.com
8. Trimco/BBW/Quality – 323-262-4191 – www.trimcobbw.com
9. Von Duprin, Inc. – 317-897-9944 – www.vonduprin.com
10. Yale Security, Inc. – 800-438-1951 – www.yalesecurity.com
11. Zero International – 800-635-5335 – www.zerointernational.com
12. McKinney - 800-346-7707 - www.mckinneyhinge.com

B. Substitutions:

1. Manufacturers and model numbers listed are to establish a standard of quality and design. The architect must approve all product substitutions. Any request for substitutions must be submitted 10 days before bid date, to allow sufficient time for addendum to be added to the bid document. In accordance with Section 01631, required data and physical samples must be provided.

2.2 MATERIALS

A. Screws and Fasteners:

1. Closers and exit devices provided for wood doors are to be furnished and installed with through bolts.
2. All finish hardware shall be installed to manufacturers' recommendations, using screws, attachments and installation tools provided with the hardware. No other screws or attachments are acceptable.

B. Hinges:

1. Template: Provide template units only.
2. Size: Provide 5" x 4 1/2" hinges on doors from 3'2" to 4'0" in width.
3. Provide non-removable pin (NRP) feature, utilizing a pointed screw, at exterior openings and where listed in the hardware sets.

4. Number of Hinges: Provide number of hinges indicated but not less than 3 hinges for door leaf for doors 90" or less in height and one additional hinge for each 30" of additional height.
5. Supply from the following list of domestic manufacturers:

    a. Hager Companies (HA).
    b. Ives Hardware (IV).
    c. McKinney Products Company (MK).

C. Locksets:

1. Locks and latch sets shall meet ANSI A156.13, Series 1000, Grade 1.
2. All locks and latch sets shall be mortise type with wrought steel case, 8" x 1 1/4" armor front, with 3/4" throw, two piece stainless steel latch bolts.
3. All locksets to be furnished with brass temporary construction cores for use during the construction phase of the project. Temporary cores to be construction masterkeyed.
4. Furnish and install dust boxes with all strikes.
5. Supply from the following list of domestic manufacturers:

    a. Yale Commercial Locks and Hardware 8807 FL Series (YA) No Substitutions.

D. Lock Trim:

1. All mortise trim shall have through-bolted installation and meet the guidelines for ADA and requirements for UFAS and ANSI 117.1, which require ease of accessibility for the handicapped and disabled.
2. The lever trim shall have cast levers with escutcheons.
3. Basis of Design: Subject to compliance with requirements, provide the following:

    a. Yale AUR (YA) No Substitutions.

E. Surface Door Closers:

1. All surface closers shall be full rack and pinion type with full molded cover and shall project no more than 2 1/4" from the mounting surface. Closers shall be provided with non-gumming and non-freezing hydraulic fluid. Closers shall have two valves, hex key adjusted to independently regulate closing and latch speed. Closers shall have two valves, hex key adjusted to independently regulate back check cushioning and back check position.
2. All closers shall also have multi-size spring power adjustment to permit setting of power from size 1 through 6.
3. Basis of Design: Subject to compliance with requirements, provide the following:

    a. LCN 4041 Series (LC).

4. Options: As dictated by codes or indicated in the drawings or hardware sets provide arm and feature options such as, adjustable delayed action, barrier-free, positive stop and/or hold open arms, low profile arms, rigid parallel arm and special mounting brackets and plates.

F. Protective Plates:

1. Armor Plates: Each Armor plate shall be .050 gauge and 34" by two (2) inches less than door width on the push side and one (1) inch less door width on the pull side of the door, with four beveled edges (4BE).
2. Provide all protection plates with countersunk screw holes and pan head machine or self-tapping screws.

G. Door Stops and Holders:

1. Wall Stops: Supply wall stops where needed to protect doors or door hardware.

H. Silencers:

1. Provide Silencers on each door frame that does not have gasket or weather strip specified.
2. Install 3 silencers on single openings.

I. Door Bottoms:

1. Provide door bottoms as listed in the hardware sets.

2.3 FINISHES

A. Provide the following finishes:

1. Swing Clear Hinges BHMA 630 Satin Stainless Steel
2. Locksets BHMA 630 Satin Stainless Steel
3. Surface Door Closers BHMA 689 Sprayed Aluminum
4. Protective Plates BHMA 630 Satin Stainless Steel

2.4 KEYING

A. General: Supplier will meet with the University’s Representative to finalize keying requirements and key all cylinders to the existing grand master key system.

B. Keying System: BHMA A156.28, Appendix A. Provide LA keyway.

1. Keyed alike: Key all cylinders to same LA keyway; deliver permanent cores to University for rekeying.

C. Keys: Provide nickel silver keys, 6-pin tumbler type, round head. Provide two blank keys for each permanent core provided. Deliver all keys to the University's Representative.

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

a. Notation: No notation stamping is required by the University.

D. Construction Keying: Provide all cylinders with brass temporary construction cores. The temporary construction cores are to be removed by the contractor after the project is completed.

E. Permanent Keying: Permanent cores are to be keyed and installed by the University. Furnish "0" bitted cores.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors, frames and related items for conditions that would prevent the proper application of any finish hardware items. Do not proceed with installation until all defects are corrected.

B. Forms shall be furnished by the gasket manufacturer to inspect related products for satisfactory tolerances before installation of doors; also for satisfactory door and frame clearances after hanging doors and prior to installation of gasket products. Forms shall include industry guidelines and recommendations for inspecting and maintaining the requirements in NFPA 80, NFPA 101, ADA and other applicable codes. The DHSI forms must be acknowledged by the site supervisor:

1. "Industry Standards and Recommended Guidelines for Installation".
2. "Installation Checklist".

3.2 INSTALLATION

A. Mount hardware units at heights indicated in "recommended Locations for Builders Hardware for Standard Steel Doors and Frames" by the Door and Hardware Institute, except as specifically indicated or required to comply with governing regulations, and except as may be otherwise directed by the architect.

B. Install each hardware item in compliance with the manufacturer's instructions and

recommendations. Wherever cutting and fitting is required to install hardware onto or into surfaces, which are later to be painted or finished in another way, coordinate removal, storage and reinstallation or application of surface protections with finishing work specified in the Division 9 sections. Do not install surface-mounted items until finishes have been completed on the substrate.

C. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

D. Drill and countersink units, which are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

3.3 FIELD QUALITY CONTROL

A. After installation has been completed, obtain the services of a qualified hardware consultant to check for proper application of finish hardware, according to the finish hardware schedule and keying schedule. In addition, check all hardware for adjustment and proper operation.

3.4 ADJUST AND CLEAN

A. Adjust, clean and inspect all hardware, to ensure proper operation and function of every opening. Replace items, which cannot be adjusted to operate freely and smoothly as intended for the application made.

B. Clean adjacent surfaces soiled by hardware installation.

C. Final adjustment: Wherever hardware installation is made more than one month prior to acceptance or occupancy of a space or area, return to the work during the week prior to acceptance or occupancy and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

D. Instruct University's personnel in proper adjustment and maintenance of hardware and hardware finishes, during the final adjustment of hardware.

E. Continued Maintenance: Approximately six months after the acceptance of hardware in each area, the installer, accompanied by the contractor, shall return to the project and re adjust every item of hardware to restore proper function of doors and hardware. Consult with and instruct University's personnel in recommended additions to the maintenance procedures. Replace hardware items, which have deteriorated or failed due to faulty materials or installation of hardware units. Prepare a written report of current and predictable problems in the performance of the hardware.

3.5 PROTECTION

A. The contractor shall use all means at his disposal to protect all finish hardware items from abuse, corrosion and other damage until the University accepts the project as complete.

3.6 HARDWARE SCHEDULE

Hardware List

Mfg	Description	Product Number	Finish
DM	Overhead Stop	911 S	689
LC	Closer	4040 XP EDA	AL
NA	Astragal	139 SP	
	Door Sweep	200 NA	
	Gasketing	5050 B-25 25'	
	Gasketing	5050 C-20 20'	
	Gasketing	5050 C-21 21'	
	Mullion Seal	5100N-96 96"	
	Saddle Threshold	425	AL
	Door Sweep	200 NA 48" SMS-TEKS 8 X 3/4"	
	Saddle Threshold	425 96" 1/4-20 MS/EA	AL
	Saddle Threshold	425 HD 36" 1/4-20-2" COMBO	AL
PR	Removable Mullion	FLKR822	689
	Exit Device	3RO 2103 X 4903A 1-3/4" 48" CD KNR S300	US32D
ST	Hinges	FBB199 4 1/2 X 4 1/2 NRP	630
	Hinges	FBB199 5 X 4 1/2 NRP	US32D
TR	Flush Bolt	3917-12	626
	Kick Plate	KO050 10" x 1" LDW B4E CSK	630
	Kick Plate	KO050 10" x 2" LDW B4E CSK	630
	Floor Stop	1211	626
	Dustproof Strike	3911	630
YA	Lockset	AUR 8805FL 7/8" SLC	630
	Cylinder	2197 7 PIN	630
	Cylinder Core	1210 0-Bitted	626
	Rim Cylinder	1193 7 PIN	630

Option List

Code	Description
CD	CYLINDER DOGGING
3RO	Prefix option for 2000 Apex Series
48"	48" Door Width

B4E	BEVELED 4 EDGES - KICK PLATES
CSK	COUNTER SINKING OF KICK and MOP PLATES
KNR	Knurled Knob/Lever
NRP	NON REMOVEABLE PIN STD/HEAVY WT HINGE
S300	STD. STRIKE - RIM AND TOP OF SVR DEVICES
1-3/4"	1-3/4" Thick Doors
0-Bitted	"0"-Bitted
7/8" SLC	MORT. LOCK STRIKE 7/8" Strk. Lip Center
1/4-20 MS/EA	1/4-20 MACHINE SCREW/EXPANSION ANCHOR
1/4-20-2" COMBO	1/4-20 X COMBO MS/ANCHOR (SS)
SMS-TEKS 8 X 3/4"	SELF DRILLING SMS 8 X 3/4"

Finish List

Code	Description
AL	Aluminum
AL	Aluminum (BHMA 689)
626	Satin Chromium Plated
630	Satin Stainless Steel
689	Aluminum Painted
US32D	Stainless Steel, Dull

Hardware Sets

SET #01 - Electrical Room HH/BR

Doors: BR02A, HH075, HH075A

8	Hinges	FBB199 5 X 4 1/2 NRP	US32D	ST
1	Removable Mullion	FLKR822	689	PR
		NOTE: 10' Opening Height		
2	Exit Device	3RO 2103 X 4903A 1-3/4" 48" CD KNR S300		630
5	Cylinder Core	1210 0-Bitted	626	YA
2	Cylinder	2197 7 PIN	630	YA
3	Rim Cylinder	1193 7 PIN	630	YA
2	Closer	4040 XP EDA	AL	LC
2	Overhead Stop	911 S	689	DM
2	Kick Plate	KO050 10" x 1" LDW B4E CSK	630	TR
2	Gasketing	5050 B-25 25'		NA
		NOTE: 10' Opening Height		
2	Mullion Seal	5100N-96 96"		NA
2	Door Sweep	200 NA 48" SMS-TEKS 8 X 3/4"		NA

1	Saddle Threshold	425 96" 1/4-20 MS/EA	AL	NA

SET #02 - Electrical Room

Doors: BR02B

3	Hinges	FBB199 4 1/2 X 4 1/2 NRP	US32D	ST
1	Exit Device	3RO 2103 X 4903A 1-3/4" 48" CD KNR S300		630
1	Cylinder Core	1210 0-Bitted	626	YA
1	Cylinder	2197 7 PIN	630	YA
1	Rim Cylinder	1193 7 PIN	630	YA
1	Closer	4040 XP EDA	AL	LC
1	Overhead Stop	911 S	689	DM
1	Kick Plate	KO050 10" x 2" LDW B4E CSK	630	TR
1	Gasketing	5050 C-20 20'		NA
1	Door Sweep	200 NA		NA
1	Saddle Threshold	425 HD 36" 1/4-20-2" COMBO	AL	NA

SET #03 - Climate Changer Room

Doors: HH075B

8	Hinges	FBB199 4 1/2 X 4 1/2 NRP	US32D	ST
2	Flush Bolt	3917-12	626	TR
1	Dustproof Strike	3911	630	TR
1	Lockset	AUR 8805FL 7/8" SLC	630	YA
		NOTE: Knurled outside Lever		
1	Cylinder Core	1210 0-Bitted	626	YA
1	Cylinder	2197 7 PIN	630	YA
2	Closer	4040 XP EDA	AL	LC
2	Overhead Stop	911 S	689	DM
2	Kick Plate	KO050 10" x 1" LDW B4E CSK	630	TR
2	Gasketing	5050 C-21 21'		NA
1	Astragal	139 SP		NA
		NOTE: Install on Active Door Pull Side		
2	Door Sweep	200 NA		NA
1	Saddle Threshold	425	AL	NA

SET #04 - Battery Storage

Doors: HH075C

3	Hinges	FBB199 4 1/2 X 4 1/2 NRP	US32D	ST
1	Lockset	AUR 8805FL 7/8" SLC	630	YA
1	Cylinder Core	1210 0-Bitted	626	YA

1	Cylinder	2197 7 PIN	630	YA
1	Closer	4040 XP EDA	AL	LC
1	Kick Plate	KO050 10" x 2" LDW B4E CSK	630	TR
1	Floor Stop	1211	626	TR
1	Gasketing	5050 C-20 20'		NA
1	Door Sweep	200 NA		NA
1	Saddle Threshold	425 HD 36" 1/4-20-2" COMBO	AL	NA

Opening List

Building Area: Battery Storage

Opening	Hdw Set	Opening Label	Door Type	Frame Type
HH075C	04		F	F1

Building Area: Electrical Room

Opening	Hdw Set	Opening Label	Door Type	Frame Type
BR02A	01		FF	F1
HH02B	02		F	F1
HH075	01		FF	F1
HH075A	01		FF	F1

Building Area: Climate Changer Room

Opening	Hdw Set	Opening Label	Door Type	Frame Type
HH075B	03		FF	F1

END OF SECTION 087100

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

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 E 119 by an independent testing agency.

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
2. Protective Coating: ASTM A 653/A 653M, G40, hot-dip galvanized unless otherwise indicated.

B. Studs and Runners: ASTM C 645**.**

1. Steel Studs and Runners:

    a. Minimum Base-Metal Thickness: 0.018 inch.
    b. Depth: As indicated on Drawings.

C. Slip-Type Head Joints: Where indicated, provide the following:

1. Deflection Track: Steel sheet top runner 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.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) ClarkDietrich Building Systems; SLP-TRK Slotted Deflection Track.
        2) MBA Building Supplies; FlatSteel Deflection Track.
        3) Steel Network Inc. (The); VertiClip SLD Series.
        4) Telling Industries; Vertical Slip Track.

D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base-Metal Thickness: 0.027 inch.

E. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

1. Minimum Base-Metal Thickness: 0.018 inch.
2. Depth: As indicated on Drawings.

F. Resilient Furring Channels: 1/2-inch deep, steel sheet members designed to reduce sound transmission.

1. Configuration: Asymmetrical or hat shaped.

G. 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 of steel sheet with minimum uncoated-steel thickness of 0.033 inch.
3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch diameter wire, or double strand of 0.048-inch diameter wire.

H. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-metal thickness of 0.018 inch, and depth required to fit insulation thickness indicated.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, 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. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.

2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

D. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.

E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch and minimum 1/2-inch wide flanges.

1. Depth: As indicated on Drawings.

F. Furring Channels (Furring Members):

1. Cold-Rolled Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch wide flanges, 3/4 inch deep.
2. Steel Studs and Runners: ASTM C 645.

a. Minimum Base-Metal Thickness: 0.018 inch.
b. Depth: As indicated on Drawings.

3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.

a. Minimum Base-Metal Thickness: 0.018 inch.

4. Resilient Furring Channels: 1/2-inch deep members designed to reduce sound transmission.

G. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

1. Basis of Design Product: Subject to compliance with requirements, provide USG Corporation; Drywall Suspension System, or comparable product by one of the following:

a. Armstrong World Industries, Inc.; Drywall Grid Systems.
b. Chicago Metallic Corporation; Drywall Grid System.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

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 C 754.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.

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

3.4 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.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch 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.

E. Z-Furring Members:

1. Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-furring members spaced 24 inches o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

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 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 unless indicated otherwise.

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. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.

D. 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.

E. 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

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SECTION 092900 - GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Interior framing systems (e.g., supports for partition walls, framed soffits, furring, etc.).
3. Interior suspension systems (e.g., supports for ceilings, suspended soffits, etc.).

1.3 SUBMITTALS

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

B. Samples: For the following products:

1. Trim Accessories: 12-inch long samples of each trim accessory indicated.

1.4 QUALITY ASSURANCE

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

1.5 STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Stack panels flat to prevent sagging.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install interior products until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are 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 PANELS, GENERAL

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

2.2 INTERIOR GYPSUM BOARD

A. General: Complying with ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. G-P Gypsum.
b. Lafarge North America Inc.
c. National Gypsum Company.
d. USG Corporation.
e. CertainTeed Corp.

B. Regular Type:

1. Thickness: As indicated
2. Long Edges: Tapered.

C. Type X:

1. Thickness: As indicated
2. Long Edges: Tapered.

D. Ceiling Type: Manufactured to have more sag resistance than regular-type gypsum board.

1. Thickness: 1/2 inch.
2. Long Edges: Tapered.

E. Moisture and Mold-Resistant Type: With moisture- and mold-resistant core and surfaces.

1. Core: 5/8 inch, Type X.
2. Long Edges: Tapered.

2.3 NON-LOAD-BEARING STEEL FRAMING, GENERAL

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
2. Protective Coating: Coating with equivalent corrosion resistance of ASTM A 653/A 653M, G40, hot-dip galvanized, unless otherwise indicated.

2.4 SUSPENSION SYSTEM COMPONENTS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch diameter wire, or double strand of 0.0475-inch diameter wire.

B. Hanger Attachments to Concrete:

1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5] times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.

a. Type: As recommended by Manufacturer.

2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch diameter.

D. Flat Hangers: Steel sheet, in size indicated on Drawings.

E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch and minimum 1/2-inch- wide flanges.

1. Depth: As indicated on Drawings.

F. Furring Channels (Furring Members):

1. Cold-Rolled Channels: 0.0538-inch bare-steel thickness, with minimum 1/2-inch-wide flanges, 3/4 inch deep.
2. Steel Studs: ASTM C 645.

a. Depth: 20 gauge (0.036 inch).

3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.

a. Minimum Base Metal Thickness: 0.0179 inch

4. Resilient Furring Channels: 1/2-inch- deep members designed to reduce sound transmission.

a. Configuration: Asymmetrical or hat shaped.

G. Grid Suspension System for Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

a. Armstrong World Industries, Inc.; Drywall Grid Systems.
b. Chicago Metallic Corporation; Drywall Furring System.
c. USG Corporation; Drywall Suspension System.

2.5 STEEL FRAMING FOR FRAMED ASSEMBLIES

A. Steel Studs and Runners: ASTM C 645.

1. Minimum Base-Metal Thickness: Min. 18 gauge unless indicated otherwise on drawings.
2. Depth: As indicated on Drawings.

B. Slip-Type Head Joints: Provide one of the following:

1. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch-deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
2. Deflection Track: Steel sheet top runner 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.

    a. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

        1) Steel Network Inc. (The); VertiClip SLD or VertiTrack VTD Series.
        2) Superior Metal Trim; Superior Flex Track System (SFT).

    b. Locations: All full height partitions extending to floor or roof deck.

C. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the 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. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

    a. Fire Trak Corp.; Fire Trak attached to studs with Fire Trak Slip Clip.
    b. Metal-Lite, Inc.; The System.

D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base-Metal Thickness: 16 Gauge (0.0598 inch).

E. Cold-Rolled Channel Bridging: 0.0538-inch bare-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.

F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

1. Minimum Base Metal Thickness: As indicated on Drawings.
2. Depth: As indicated on Drawings.

G. Resilient Furring Channels: 1/2-inch- deep, steel sheet members designed to reduce sound transmission.

1. Configuration: Asymmetrical or hat shaped.

H. Cold-Rolled Furring Channels: 0.0538-inch bare-steel thickness, with minimum 1/2-inch- wide flanges.

1. Depth: As indicated on Drawings.
2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum bare-steel thickness of 0.0312 inch.
3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch-diameter wire, or double strand of 0.0475-inch- diameter wire.

I. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum bare-metal thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.

2.6 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.
2. Shapes:

a. Cornerbead.

B. Aluminum Trim: Extruded accessories of profiles, dimensions, and locations as indicated on Drawings.

1. Manufacturers: Basis of Design shall be Softforms, SWR Series by Pittcon Softforms, LLC, or comparable products by one of the following:

a. Fry Reglet Corp.

2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.7 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Wallboard: Paper.

2. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Wallboard: 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 drying-type, all-purpose compound.

a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use drying-type, all-purpose compound.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.

2.8 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Isolation Strip at Exterior Walls: Provide one of the following:

1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
2. 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 and framing, for compliance with requirements and other conditions affecting performance.

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 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

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, except floors. 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.

3.3 APPLYING 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-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 1 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. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
4. Fastening Methods: Fasten base layers with screws; fasten face layers with adhesive and supplementary fasteners.

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 recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.4 METAL FRAMING INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754, except comply with framing sizes and spacing indicated.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support surface-mounted fixtures, equipment services, heavy trim, grab bars, toilet accessories, shelves, furnishings, door stops, and similar construction.

C. Install bracing at terminations in assemblies.

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

3.5 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.

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. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
5. Do not attach hangers to steel roof deck.
6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
8. 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.

3.6 INSTALLING FRAMED ASSEMBLIES

A. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

B. Install studs so flanges within framing system point in same direction.

1. Space studs as follows:

a. Single-Layer Application: As indicated on Drawings.
b. Multilayer Application: As indicated on Drawings.
c. Tile backing panels: As indicated on Drawings.

C. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.

2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb, unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch 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.

D. Direct Furring:

1. Screw to wood framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

E. Z-Furring Members:

1. Erect insulation (specified in Division 07 Section "Thermal Insulation") vertically and hold in place with Z-furring members spaced 24 inches o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

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.

3.7 INSTALLING 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 C 840 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.

3.8 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 those with trim having flanges not intended for tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Where indicated on Drawings.
3. Level 3: Where indicated on Drawings.
4. Level 4: At panel surfaces that will be exposed to view, unless otherwise indicated.

    a. Primer and its application to surfaces are specified in other Division 09 Sections.

3.9 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. 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 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes surface preparation and the application of paint systems on interior substrates.

B. Primers listed in Paint Schedule are in addition to shop-applied primers specified in other Sections.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

B. Samples for Initial Selection: For each type of topcoat product.

C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches square.
2. Step coats on Samples 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 List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. VOC content.

E. Alternative paint manufacturers and products requested for approval. Show equal products by comparison with Basis of Design products.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. 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 specified in Part 3.

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 less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide The Sherwin Williams Co. or comparable product by one of the following:

1. Glidden Professional.
2. Benjamin Moore & Co.
3. Duron, Inc.

2.2 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Dry-Fog Coatings: 400 g/L.
4. Primers, Sealers, and Undercoaters: 200 g/L.
5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Floor Coatings: 100 g/L.
9. Shellacs, Clear: 730 g/L.
10. Shellacs, Pigmented: 550 g/L.

2.3 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Masonry (Clay and CMU): 12 percent.
3. Gypsum Wallboard: 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 INSPECTION

A. Thoroughly examine surfaces scheduled to be painted prior to commencement of work. Report in writing any condition that may affect proper application. Do not commence work until such defects have been corrected.

B. Where materials are being applied over previously painted surfaces or questionable surfaces, apply samples and perform in place test to check for compatibility, adhesion and film integrity of new materials to existing painted surfaces. Report in writing any condition that may affect application, appearance or performance of the paint.

C. Painting of surface constitutes contractor's acceptance of surface and responsibility for any paint failure.

3.3 PREPARATION

A. Comply with manufacturer's written instructions and recommendations applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

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. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceed that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:

1. SSPC-SP 2, "Hand Tool Cleaning."

2. SSPC-SP 3, "Power Tool Cleaning."

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and 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 fabricated from coil stock 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.

3.4 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations.

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.

3.5 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.6 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

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.

3.7 SCHEDULE - INTERIOR SURFACES – LATEX (Low VOC. Meets Federal OTC regulations)

A. Refer to “Interior Finishes” on drawings for additional information.

B. Shop Primed Ferrous Metal: Semi-Gloss Latex:

1. Sherwin-Williams:

a. Primer: Compatible type recommended by the finish coat manufacturer.
b. Finish: Two coats ProMar 200 Interior Latex Semi-Gloss B28 W200.

C. Ferrous Metal: Semi-Gloss Latex:

1. Sherwin-Williams:

a. Primer: One coat DTM Acrylic B66 Primer/Finish Paint.
b. Finish: Two coats ProMar 200 Interior Latex Semi-Gloss.

D. Galvanized Metals: Semi-Gloss Latex: Pretreat as required by manufacturer.

1. Sherwin-Williams:

a. Primer: One coat DTM Acrylic B66 Primer/Finish Paint.
b. Finish: Finish: Two coats ProMar 200 Interior Latex Semi-Gloss.

E. Concrete Masonry Units: Semi-Gloss Latex:

1. Sherwin-Williams:

a. Filler: One coat Prep Rite Block Filler B25 W25.
b. Finish: Two coats ProMar 200 Interior Latex Semi-Gloss.

F. Gypsum Board: Eggshell Latex:

1. Sherwin-Williams:

a. Primer: One coat PrepRite 200 Latex Wall Primer (B28 W200).
b. Finish: Two coats ProMar 200 Latex Egg-Shell Enamel B20.

END OF SECTION 099123

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SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. 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. Coordinate final fire extinguisher schedule with fire protection cabinet schedule to ensure proper fit and function.

1.4 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.6 QUALITY ASSURANCE

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.

C. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to fire extinguishers including, but not limited to, the following:

a. Schedules and coordination requirements.

1.7 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. Failure of hydrostatic test according to NFPA 10.
b. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. J. L. Industries, Inc.
b. Larsen's Manufacturing Company.
c. Potter Roemer LLC.

2. Valves: Manufacturer's standard.
3. Handles and Levers: Manufacturer's standard.
4. 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:80-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.2 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 baked-enamel finish.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. J. L. Industries, Inc.
b. Larsen's Manufacturing Company.
c. Potter Roemer LLC.

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: 54 inches above finished floor to top of fire extinguisher.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 104416

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SECTION 210000 – BASIC MECHANICAL REQUIREMENTS – FIRE PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01Specification Sections, apply to this section and all other sections of Division 21.

1.2 SUMMARY

A. This Section includes the requirements for the following:

1. Codes, organizations, standards, and abbreviations
2. Fire protection design criteria and requirements
3. Designer/installer qualifications
4. Submittals
5. Site Visit
6. Outages
7. Cutting, welding and burning
8. Performance requirements
9. Material and equipment
10. Related work
11. Contract drawings.
12. Coordination
13. Demolition
14. Fire safe materials
15. UL requirements
16. Coordination drawings
17. Construction record documents
18. Operation and maintenance manuals
19. Fire stops and smoke seals
20. Guarantee / Warranty
21. Concrete pump base and grout
22. Equipment roughins
23. Cutting and patching
24. Installation requirements common to equipment specification sections
25. Excavation and back fill
26. Temporary service
27. Demonstrations
28. Final cleaning
29. Project punchout

1.3 CODES, ORGANIZATIONS, STANDARDS AND ABBRIVIATIONS

A. The following list of codes, organizations, standards and abbreviations are utilized within Division 21 Specification Sections and are provided as a reference.

B. Codes: All material and equipment provided and installed as part of these construction documents shall be in compliance with the latest edition of the following codes as adapted by the State of Maryland for the following:

1. IBC: International Building Code
2. IMC: International Mechanical Code
3. IECC: International Energy Conservation Code
4. Maryland State Fire Prevention Code
5. NEC: National Electrical Code
6. NFPA 1: Fire Code
7. NFPA 101: Life Safety Code
8. PHCC: National Standard Plumbing Code Illustrated

C. Organizations and Standards: Referenced organizations and standards are as follows:

1. ADA: American Disability Act
2. AEC: Architecture, Engineering and Construction
3. ANSI: American National Standards Institute
4. ASME: American Society of Mechanical Engineers
5. ASTM : American Society for Testing and Materials
6. ATA: American Translator Association
7. ATL: Aero Tec Laboratories
8. AWS: American Welding Society
9. AWWA: American Water Works Association
10. CS: Commercial Standard
11. CSA: Canadian Standards Association
12. FM: Facilities Management, Factory Mutual
13. MOSHA: Maryland Occupational Safety and Health Administration
14. MSSP: Manufacturers Standards Society of the Valve and Fittings Industry
15. NEMA: National Electrical Manufacturers Association
16. NFPA: National Fire Protection Association
17. NICET: National Institute for Certification in Engineering Technologies
18. NPS: National Pipe Standard
19. OSHA : Occupational Safety and Health Administration
20. SAE: Society of Automotive Engineers
21. UB: University of Baltimore
22. UL: Underwriters' Laboratories
23. UM: University of Maryland
24. UMB: University of Maryland, Baltimore
25. UMB-A/E: University of Maryland, Baltimore Architect/Engineer
26. UMB-FM: University of Maryland, Baltimore – Facilities Management

27. UMB-PM: University of Maryland, Baltimore Project Manager
28. UMBC: University of Maryland, Baltimore County

D. Abbreviations: Referenced abbreviations are as follows:

1. AC: Alternating Current
2. A/E: Architect/Engineer
3. AWG: American Wire Gauge
4. CAD: Computer Aided Design
5. CD-ROM: Compact Disk – Read Only Material
6. CM: Construction Manager
7. CMU: Concrete Masonry Unit
8. DOC: Document
9. FM: Facilities Management, Factory Mutual
10. Dwg: Drawing
11. EDPM: Ethylene Propylene Diene Terpolymer Rubber
12. EMT: Electrical Metallic Tubing
13. FM: Facilities Management
14. HOA: Hand Off Auto
15. HVAC: Heating Ventilation and Air Conditioning
16. ID: Inside Diameter
17. LED: Light Emitting Diode
18. LF: Linear Feet
19. MC: Metal Clad
20. MPa: Megapascal
21. NBR: Acrylonitrile-Butadiene, Buna-N, or Nitrile Rubber
22. NPS: National Pipe Standard
23. OD : Outside Diameter
24. Pdf: Portable Document Format
25. PSI: Pounds per Square Inch
26. PVC: Polyvinyl Chloride
27. RPM: Revolutions Per Minute

1.4 FIRE PROTECTION DESIGN CRITERIA AND REQUIREMENTS

A. Fire Protection Design Criteria: For Sprinkler System Design, Installation and Water Supply Requirements for all new construction and/or renovation projects on UMB's Campus use an occupancy classification of Ordinary Hazard – Group 1 as the basis of design unless otherwise directed by UMB.

B. Design and Installation: The sprinkler equipment manufacturer, designer and installer shall have been engaged in the manufacturer, design, installation and testing of sprinkler equipment for a minimum of not less than five (5) consecutive years..

C. System Modifications: All modifications to the existing sprinkler systems including piping, valves, alarms, sprinkler heads etc. shall be in accordance with NFPA - 13, latest edition, and as approved by the UMB Fire Marshal.

D. Floor Zones: Each floor/area shall be a separate zone from the balance of the building. Sprinkler system design shall ensure that 100 psi is available at the most remote fire hose connection in the system.

E. Sprinkler Heads: Sprinkler heads shall be provided as required by NFPA. Sprinkler head locations shall be coordinated with the architectural reflected ceiling plans.

F. New Construction: For New Construction Projects provide a Standpipe Riser for each Stairwell with a Fire Hose Connection on each level and at least one (1) Sprinkler Floor Zone Assembly per Floor. Where additional Sprinkler Floor Zone Assemblies may be required coordinate the number, and location of these assemblies with the UMB Fire Marshal and UMB Engineer.

G. Renovation Projects: For Campus Renovation Projects where portions of existing buildings are renovated, the number of Sprinkler Floor Zone Assemblies in the project area shall be the same as the rest of the building. Additional Floor Sprinkler Zones will not be allowed.

1. When the Existing Sprinkler Standpipe Riser and Sprinkler Floor Zone Assembly is within the project renovation area the existing Riser and Sprinkler Floor Zone Assembly shall be replaced with a New Riser, and Sprinkler Floor Zone Assembly. The new riser section shall be the same size as the existing riser between the floor slabs.

1.5 DESIGNER/INSTALLER QUALIFICATIONS

A. Installers Qualifications: The designer and installer of the fire protection system shall be a company who has been engaged in the sprinkler industry for a minimum of five (5) consecutive years and must be licensed by the Maryland State Fire Marshal’s Office. Equipment and installations shall comply with the year edition of NFPA 13 which is applicable within the State of Maryland at the time of contract execution. NICET certification is required for designers and installers.

1.6 SUBMITTALS

A. General: For general requirements see Architectural Specification Division 01 Section "Submittals".

B. In addition to the requirements identified in Architectural Specification Division 01 Section "Submittals" the fire protection contractor shall also comply with the following:

1. Submit drawings, hydraulic calculations, diagrams, schedules, samples and manufacturers catalogue cuts as one (1) complete set. The complete submittal set must be reviewed and approved by UMB Fire Marshal and Engineer before installation can take place. Partial Submittals will be rejected.

2. Detailed, dimensioned layout and working drawings/plans, together with descriptive specifications, schedules, and engineering data sheets for all manufactured material and equipment, shall be submitted for review. Drawings shall indicate the ceiling grid, lighting fixtures, air devices, etc. Any cost incurred for changes/corrections required by the UMB Fire Marshal shall be borne by the contractor.

3. Any deviations from the approved drawings shall be re-submitted to the UMB Fire Marshal's office for re-approval. The costs for corrections required by the UMB Fire Marshal shall be borne by the contractor.

C. Fire Protection Submittals: Provide submittals for all material, equipment and/or supports as specified in Division 21 and where indicated on the drawings and details. For additional material and data submission requirements see Division 21 Specification Sections. At a minimum the following submittals shall be provided as required by the project:

1. Sleeves, sleeve seals, and escutcheons.
2. Labels and signs.
3. Pipe, fittings and joints.
4. Valves and inspectors test assembly.
5. Supervisory and flow switches.
6. Cabinets.
7. Pressure gauges.
8. Hangers and supports.
9. Elevator key storage.
10. Sprinkler heads.
11. Inspectors test.
12. Wet pipe system and components.
13. Dry pipe system and components.
14. Pre-action system and components.
15. Hydraulic calculations.
16. Material and/or equipment samples when specified.
17. Coordinated drawings.

D. Submittal File Formats: File formats for each submittal shall be electronically as follows:

1. Product Data: "pdf" file format.
2. Shop Drawings: "pdf" and "dwg" file formats.
3. Coordinated Drawings: "pdf" or "dwg" file formats.

4. Schedules: “xl” file format.

E. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

1.7 SITE VISIT

A. Prior to preparing the bid, the fire protection subcontractor shall visit the site and become familiar with all existing conditions. Make all necessary investigations as to locations of utilities and all other matters which can affect the work. No additional compensation will be made to the contractor as a result of his failure to familiarize himself with the existing conditions under which the work must be performed.

1.8 OUTAGES

A. For all work requiring an outage, the fire protection subcontractor shall submit an outage request to the UMB Project Manager, using the UMB Standard Request for Outage Form which is available through the UMB Design and Construction Web Site at http://www.umaryland.edu/designandconstruction/, under the Documents Link. The existing fire protection system shall remain operational unless turned off by University personnel during the construction of the project.

B. Unless otherwise specified, outages of any services required for the performance of this contract and affecting areas other than the immediate work area shall be scheduled at least ten days (10) days in advance with the Office of Facilities Management. All such outages shall be performed on other than normal duty hours.

C. All fire protection outages which will interfere with the normal use of the building in any manner shall be done at such times as shall be mutually agreed upon by the contractor, the UMB Fire Marshal and the Office of Facilities Management.

D. The fire protection contractor shall include in his price the cost of all premium time required for outages and other work which interferes with the normal use of the building, which will be performed, in most cases, during other than normal work time and at the convenience of the University.

E. The operation of fire protection valves required to achieve an outage must be accomplished by University personnel only. Prospective subcontractors under this section are cautioned that the unauthorized operation of fire protection valves or other control devices by their personnel can result in extremely serious consequences for which the contractor will be held accountable.

1.9 CUTTING, WELDING, BURNING

A. Before the contractor and/or any sub-contractor commences any cutting, welding, burning, brazing (pipe sweating), the contractor shall obtain a hot work permit from Environmental Health and Safety at extension 1-410-706-3490.

B. The hot work permit copy shall remain on the job site at the hot work location until such work is completed at which time the permit shall be returned to Environmental Health and Safety.

1.10 PERFORMANCE REQUIREMENTS

A. Contract drawings are generally diagrammatic and do not indicate all offsets, fittings, transitions, access panels and other specialties required.

B. Furnish and install all items as may be required to fit the work to the conditions encountered.

C. Arrange piping, equipment and other work generally as shown on the contract drawings, and fire protection shop drawings providing proper clearances and access.

D. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawing submittal for approval in accordance with Submittals specified below.

E. The Architect may make reasonable changes in location of equipment piping and ductwork up to the time of rough-in or fabrication.

1.11 MATERIALS AND EQUIPMENT

A. The contract drawings and system performances have been designed on the basis of using the particular manufacturer's products specified or scheduled on the contract drawings.

B. Products of other manufacturer's listed in the specification shall be permitted provided as follows:

1. Products meet all of the requirements of the specifications.
2. Make, without additional cost to the Owner, all adjustments for deviations, such that the final installation is complete and functions as the basis of design product is intended.

C. Products with dimensions or other characteristics different from the basis of design product that render their use impractical or cause functional fit, access, or connection problems, shall not be acceptable.

D. Each item of equipment shall be capable of performing its function over an extended period of time with a minimum of attention and maintenance. All equipment and material

shall be constructed using new materials designed and built in accordance with the best practices of the industry. Each item of equipment shall be listed in the Underwriters Laboratories Fire Protection Equipment List or Factory Mutual Approval Guide. Each major item of equipment shall bear the manufacturer's name or trademark; serial number; U.L. or F.M. label; operating instructions and hydraulic characteristic conditions, etc., where applicable.

1.12 RELATED WORK

A. All work shall be properly coordinated with the design and installation of fire alarm equipment including but not limited to electrical (Wire and cable, raceway systems, junction boxes, emergency illumination, etc.), floor service or laboratory equipment, HVAC equipment, heating, ventilation, air conditioning and refrigeration piping, suppression systems (sprinkler, standpipe, gaseous suppression system tanks, etc.)

1.13 COORDINATION

A. Coordination: Coordinate fire protection systems, equipment, and materials installation with other building components.

B. Utilities: Coordinate connection of fire protection systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

C. Chases: Arrange for chases, slots, and openings in building structure during progress of construction to allow for fire protection installations.

D. Sleeves: Coordinate the installation of required supporting devices and set sleeves in poured in place concrete and other structural components as they are constructed.

E. Sequencing: Sequence, coordinate, and integrate installations of fire protection material and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.

F. Electrical Services; Coordinate connection of electrical services.

G. Access: Coordinate requirements for access panels and doors where fire protection items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Architectural Specification Section "Access Doors."

H. Scheduling: Schedule and coordinate the delivery of material and equipment with other trades to avoid delivery conflicts.

1.14 DEMOLITION

A. Cut, remove and legally dispose of selected Fire Protection piping, equipment, components, and materials as indicated, including but not limited to removal of Fire Protection piping, Fire Protection equipment, ductwork, plumbing fixtures and trim, and other Fire Protection items made obsolete by the new work.

1.15 FIRE SAFE MATERIALS

A. Unless otherwise indicated, materials shall conform to UL, NFPA or ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of twenty five (25) and smoke development of fifty (50).

1.16 UNDERWRITER'S LABORATORY (UL) REQUIREMENTS

A. All equipment containing electrical components and provided as part of the fire protection specifications shall bear the Underwriter's Laboratory (UL) label, as a complete packaged system.

1. Equipment not provided with a UL label shall be tested in the field, certified and provided with a UL label at the installer's expense.
2. Field testing shall be performed by a testing agency approved by the authority having jurisdiction.

1.17 CONSTRUCTION RECORD DOCUMENTS

A. The sprinkler contractor shall maintain a set of construction record documents during the construction period in accordance with Specification Division 01 Section "Contract Closeout."

1.18 OPERATION AND MAINTENANCE MANUALS

A. Prepare one (1) electronic maintenance manual file in "pdf" format in accordance with Specification Division 01 Section "Project Closeout."

PART 2 – PRODUCTS

2.1 LISTED MANUFACTURERS:

A. Listed Manufacturers: The listed manufacturers indicated in Part 2 of each specification section as the basis of design represents the minimum level of quality for materials and equipment that is acceptable to UMB. Unless otherwise indicated in each specification section, contractors may submit material and equipment by non listed manufacturers provided said submittals meet all of the requirements of these specifications. All submitted materials and equipment are subject to approval by the A/E and UMB.

B. Approved Equal Equipment Layouts: The equipment layouts and the related mechanical and electrical service connections, access space and supports indicated on the construction documents represent equipment provided by the specified basis of design manufacturer and model number. When the successful bidder chooses to provide "or approved equal" equipment by one (1) of the other listed manufacturers in the specifications, the bidder shall be responsible for providing all adjustments and modifications to the services necessary to make connections to the equipment, the bidder shall be responsible for installing the equipment such that all required clear access space is maintained, and the bidder shall be responsible for providing all adjustments and modifications to the equipment mounting and supports. All adjustments and modifications shall be provided by the bidder and appropriate subcontractors at no additional cost to the project.

2.2 COMBINATION MOTOR STARTERS AND CONTROLLERS – FIRE PROTECTION EQUIPMENT

A. Combination motor starters and/or controllers shall be provided for all motors serving HVAC equipment as follows:

1. Skid Mounted Equipment: Combination motor starters and/or controllers shall be provided by the equipment manufacturer as part of Division 21.
2. Non Skid Mounted Equipment: Combination motor starters and/or controllers shall be provided as part of Division 26.

PART 3 - EXECUTION

3.1 EXISTING FIRE PROTECTION SYSTEM

A. Building System: In no case shall any portion of a buildings fire protection system be taken out of service for more than four (4) hours in a twenty four (24) hour period without the written approval of UMB Fire Marshal.

B. Project Area: The parts of the fire protection system serving the project area can be placed out of service for periods of construction not exceeding four (4) hours. Coordination of the outage must be made with the project manager. When the construction is completed the fire protection system serving the project area shall be placed back in service. The operation of existing fire protection system valves to isolate the project area shall be accomplished by university personnel only. Submit an outage request for this work as specified.

C. Fire Watch: When a portion of the buildings fire protection system is taken out of service for a period of time exceeding ten (10) hours in a twenty-four (24) hour period, the sprinkler contractor shall comply with the following:

1. Eliminate potential ignition sources and limit the amount of fuel available to a fire.
2. Install a tag(s) to indicate the part of the system that has been removed from service. The tag(s) shall be installed on all components of the system that will be out of service.
3. Arrange for an approved fire watch.

3.2 EQUIPMENT ROUGH IN

A. Verify final locations for rough in's with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to approved equipment submittals for actual rough in requirements.

3.3 MECHANICAL INSTALLATION - FIRE PROTECTION

A. Verify all dimensions by field measurements.

B. Where fire protection systems, materials and equipment are intended for overhead installation, and where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible. Notify UMB - PM prior to installation of sprinkler system components when headroom is less than 7'-6" and/or where existing system components will be below the new finished ceiling height. Notification shall be through the "RFI" process.

C. Install fire protection systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, identify the conflict and submit and "RFI" for each conflict to the Architect.

D. Install fire protection systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.

E. Install fire protection equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

F. Install fire protection systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.4 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Specification Division 01 Section "Cutting and Patching" In addition to the requirements specified in Specification Division 01, the following requirements apply:

1. Patch Materials: Patch finished surfaces and building components using new materials specified for the original installation and using experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

B. Cut, remove and legally dispose of selected fire protection equipment, components, and materials as indicated, including but not limited to removal of fire protection piping, sprinkler heads and trim made obsolete by the new work.

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS D1.1 "Structural Welding Code--Steel."

3.6 DEMOLITION

A. Disconnect, demolish, and remove work specified as part of the fire protection specifications and as indicated. Remove pipes back to the active pipe to remain and cap.

B. Accessible Work: Remove indicated exposed pipe and ductwork in its entirety.

C. Removal: Remove indicated equipment from the Project site.

3.7 CLEANING AND FINISHES

A. Clean surfaces prior to application of insulation, adhesives, coating, and paint.

B. Provide factory applied finish where specified.

C. Protect all finishes, and restore all finishes to their original condition if damaged as a result of work installed as part of the mechanical specifications.

D. Remove all construction marking and writing from exposed equipment, piping and building surfaces.

3.8 LINTELS

A. Lintels shall be provided for openings in masonry, brick, concrete, etc. walls to accommodate work of this division.

1. Lintels shall be provided under this division when not being provided under other divisions. Lintels shall be approved by the Architect.

3.9 ELECTRICAL REQUIREMENTS

A. Unless otherwise indicated, furnish and install control and interlock wiring for the equipment furnished under this division. In general, power wiring and motor starting equipment will be provided as specified in the Division 26 Specifications.

1. Where the electrical requirements of the equipment furnished differ from the provisions made in the Division 26 Specifications, make the necessary allowances as part of the Mechanical Specifications.
2. Where no electrical provisions are included in the Division 26 Specifications, include all necessary electrical work as part of the Mechanical Specifications.

B. All electrical work performed as part of the mechanical specifications shall be provided in accordance with the Division 26 Specifications.

3.10 PROVISIONS FOR ACCESS

A. Insure adequate access is provided to all fire protection system components. The following list shall be used as a guide only:

1. Equipment.
2. Valves.
3. Drain points.

B. Access shall be adequate as determined by the A/E and UMB representatives.

C. Refer to contract drawings where access panels have been specifically located.

D. Where access is by means of lift out ceiling tiles or panels mark each access panel using small color coded or numbered tabs. Provide an index chart for identification. Place markers in corner of tile.

3.11 TEMPORARY SERVICE AND EQUIPMENT USE

A. Temporary Service: Do not use, fire protection systems for temporary services during construction unless authorized in writing by the A/E and the UMB Fire Marshal.

B. Equipment Use: Where such authorization is granted, temporary use of equipment shall not limit or otherwise affect warranties or guarantees of the work.

3.12 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of equipment and systems to Owner's personnel a minimum two (2) weeks prior to date of final inspection.

1. For equipment requiring seasonal operation, perform instructions for other seasons at the same time.
2. Training period shall be performed within one (1), two (2) week period.

B. Use operation and maintenance manuals and video as basis of instruction. Review contents of manual and video with personnel in detail to explain all aspects of operation and maintenance.

C. Demonstrate the following:

1. Start up.
2. Operation.
3. Control.
4. Servicing.
5. Maintenance.
6. Shutdown.

D. Provide at least forty (40) hours straight time instruction to the operating personnel.

1. This instruction period shall consist of not less than five (5) eight (8) hour days.
2. Time of instruction shall be designated by the Owner.
3. This instruction shall be in addition to instructional requirements of specific equipment specified elsewhere in the mechanical specifications.

3.13 WALL AND FLOOR PENETRATION

A. All penetrations of partitions, walls and floors by sprinkler piping and/or conduit installed under Division 21 shall be sealed and caulked. Provide U.L. listed fire stopping systems at penetrations through fire walls as specified in the Architectural Specifications.

3.14 CONSTRUCTION RECORD DRAWINGS

A. As the work progresses, the contractor shall record on one (1) set of prints, the installed locations, sizes, and depths of pipes, services, equipment, etc. which may differ from the approved contract drawings.

B. Upon completion of the fire protection system installations, the sprinkler contractor shall deliver to the construction manager one (1) complete set of marked-up blueprints of the fire protection system installation drawings along with the electronic "dwg" file indicating the "As Built" condition. The "As Built" condition shall include all

construction revisions due to field conditions, “RFI’s”, “CB’s”, “ASI’s” and/or owner requested revisions.

1. The mark-ups shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design.
2. Refer to General Requirements of Specification Division 01 for additional requirements pertaining to Submittals and Record Drawings.
3. Unless otherwise directed by UMB the electronic file shall be submitted to the construction manager in Auto Cad Release 2016 or latest edition on a CD- Rom with All "Record Drawing" information neatly recorded thereon in red ink. The A/E shall verify that all “Record Drawing” information has been recorded on the electronic file. The electronic file and mark up set shall be turned over to UMB by the A/E.

C. At a minimum include the following installed conditions shall be recorded:

1. Location of all shut off valves, drain valves, and balancing valves with assigned valve tag numbers.
2. Show the location of concealed material and/or equipment requiring service.
3. Actual entering/leaving invert elevations for fire protection water service for the building.

3.15 FINAL CLEANING

A. General: General cleaning during construction is required by the General Conditions as indicated in Division 01 Specification Section “Temporary Facilities.”

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.

C. Remove all mechanical clipping, wiring, nuts, bolts, etc. left on top of ceilings and ceiling tiles.

3.16 PROJECT PUNCH OUT

A. Architect/Engineer will perform punch out reviews and will provide the Contractor with a list of punch list items to be completed before contract close out. Each and every punch list item shall be initialed and dated by the Contractor when the work is complete. The Architect/Engineer will not perform any punch list verification until all items have been completed, initialed, dated and the list returned to the Architect/Engineer. If any items have been initialed as being completed by the Contractor and the Architect/Engineer determines that the work is not complete, the Architect/Engineer shall be reimbursed by the Contractor at his regular hourly rate for any and all items requiring revisiting of the

site by the Architect/Engineer. Reimbursement shall be made by deducting the Architect/Engineer fee from the Contractor's final payment.

END OF SECTION 210000

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SECTION 211313 – FIRE PROTECTION SPRINKLER SYSTEMS & STANDPIPES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 21.

1.2 SUMMARY

A. This section includes requirements for furnishing, a complete fire protection and standpipe system and/or modifying an existing system including the following:
   1. Pipe, fittings, and joints.
   2. Valves and inspectors test assembly
   3. Supervisory and flow switches.
   4. Cabinets.
   5. Pressure gauges.
   6. Hangers.
   7. Sprinkler heads.
   8. Dry fire protection system and accessories shop drawing.
   9. Pre-action fire protection system and accessories shop drawing.

1.3 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, wirings diagrams, power requirements, specified options, and warranty information.

B. Shop Drawings: For each fire protection system, include a complete fire protection system layout indicating the location, elevation, and sizes of the distribution piping, stand pipes, floor zone valves, related hangers, and sprinkler heads and include all required dimensional data. Also include the location of the water service entrance to the building, the fire pump, and components for a dry pipe or pre-action system and equipment power requirements. The system layout must be coordinated with the work of all other trades, light fixtures, air devices and ceiling systems.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

   2. Sprinklers shall be referred to on drawings and shall be specifically identified by the listed manufacturer’s style or series designation. Trade names and abbreviations are not permitted.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Product Data: Include a copy of the approved submittal for each product and material along with applicable maintenance data in the project operation and maintenance manual.

B. Operation and Maintenance Shop Drawing Data: Include a copy of the approved shop drawings and hydraulic calculations for each type of fire protection system in the operation and maintenance manual.

C. File format:

1. Product Data and Hydraulic Calculation Files: Submit product data and hydraulic calculation files in “pdf” format.
2. Shop Drawing Data: Submit file in “dwg” and “pdf” format.

1.6 PROJECT REQUIREMENTS

A. All modifications to the existing sprinkler systems including piping, valves, alarms, sprinkler locations, etc. shall be in accordance with NFPA - 13, latest edition, and as approved by the UMB Fire Marshall.

B. The sprinkler equipment manufacturer, designer and installer shall have been engaged in the manufacturing, design, installation and testing of sprinkler equipment for a minimum of not less than five consecutive years. NICET certification is requested.

C. Sprinklers shall be provided as required by NFPA. Sprinkler locations shall be coordinated with the architectural reflected ceiling plans.

D. Each floor/area shall be a separate zone from the balance of the building. Sprinkler system design shall ensure that 100 psi is available at the most remote fire hose connection in the system.

E. For New Construction Projects provide a Standpipe Riser for each Stairwell with a Fire Hose Connection on each level. Provide at least one Sprinkler Floor Zone Assembly per floor. Where additional Sprinkler Floor Zone Assemblies may be required, coordinate the number and location of these assemblies with the UMB Fire Marshall and UMB Engineer.

F. For Campus Renovation Projects where portions of existing buildings are renovated, the number/distribution of Sprinkler Floor Zone Assemblies in the project area shall be the same as the rest of the building. Additional Floor Sprinkler Zones will not be allowed.

1. When the Existing Sprinkler Standpipe Riser and Sprinkler Floor Zone Assembly is within the project renovation area, the existing Riser and Sprinkler Floor Zone Assembly shall be replaced with a New Riser and Sprinkler Floor Zone Assembly. The new Riser section shall be the same size as the existing riser between the floor slabs.

1.7 QUALITY ASSURANCE

A. The contractor shall also, during the two (2) year guarantee period, be responsible for the proper adjustment on all systems, equipment, and apparatus, installed by him and do all the work necessary to ensure safe, efficient, and proper functioning of the systems and equipment at no cost to the University.

1.8 WARRANTY/GUARANTEE

A. See Division 21 Specification Section "Basic Mechanical Requirements – Fire Protection" for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. System Material and Design: The sprinkler system, standpipes, and all components and accessories shall be designed and selected for the intended use, in accordance with NFPA 13 and the requirements of this specification.

B. Pipe, Fittings and Joints: All Pipe, Fillings, and Joints used for Standpipe and Sprinkler Systems shall be as specified. Copper or Thin Wall (such as Allied XL, Schedule 10 Piping) or Plastic pipe shall not be used.

2.2 PIPE, FITTINGS, & JOINTS

A. All Grooved Couplings and Fittings shall be the product of one (1) manufacturer. Grooving Tools shall be of the same Manufacturer as the grooved components. The Contractor shall be responsible for replacing any Fitting, Coupling, Gasket or Device that was installed and is not included in the approved submittal. Pipe Material:

1. For Piping one half (1/2) inch to one and one half (1-1/2) inch use Schedule 40 Black Steel Pipe, 150 lb. ASTM A53 for Black Steel Pipe.
2. For Piping two (2) inches to eight (8) use Victaulic Rolled Grooved End Schedule 40 Black Steel Pipe, 150 lb. ANSI Class, ASTM F-1476. Grooved Ends shall be in accordance with dimensions specified by the Victaulic Company USA.
3. All Piping subject to moisture and/or installed exposed to weather shall be Schedule 40 Hot Dipped Zinc Coated Galvanized Steel Pipe 150 lb. ASTM A 795 for Fire Protection Use. Galvanizing shall be in accordance with ASTM A – 153.

B. Fitting Material:

1. Fittings for Piping one half (1/2) inch to one and one half (1-1/2) inch shall be Malleable Iron Threaded Fittings for Elbows, Tees, Increasers, Reducers, 'Y' Fittings, and Thread-O-Lets conforming to ASME B 16.3, Class 150. Threads shall be per ANSI b.1.20.1.
2. Fittings for Piping two (2) inches to eight (8) inches shall be Ductile Iron Grooved End Fittings for Elbows, Tees, Increasers, Reducers, 'Y' Fittings, conforming to ASTM A - 395, Grade 65-45-15 and ASTM A - 536, Grade 65-45-12 grooved to accept Victaulic Firelock Couplings, Victaulic Short Pattern Fittings Style 001, 002, 003, 006, and 744 Flange Adapters. Fittings shall be short pattern, with flow equal to standard pattern fittings.
3. All Fittings subject to moisture and/or installed exposed to weather shall be Schedule 40 Hot Dipped Zinc Coated Galvanized Steel Pipe 150 lb. ASTM A 795 for Fire Protection Use. Galvanizing shall be in accordance with ASTM A – 153.

C. Joint Material:

1. Joints for Piping one half (1-1/2) inch to one and one half (1-1/2) inch shall be Threaded Joints conforming to American Standard for Pipe Threads ANSI B2.1.

2. Joints for piping two (2) inches to twelve (12) inches shall be Victaulic Installation Ready Style 009H and 107N Ductile Iron Couplings with offset angled bolt pads to accomplish rigidity and provide support in accordance with NFPA - 13. Couplings shall be fully installed at visual pad to pad offset contact. Couplings that require gapping of bolt pads or specific torque ratings for proper installation are not permitted. Gasket Material shall be Grade 'EHP' EPDM-HP or 'E' EPMD gasket material. All Joints shall be provided with ASTM A449 zinc electroplated Carbon Steel Nuts and Bolts. Housings shall be Cast Ductile Iron, conforming to ASTM A - 395, Grade 65-45-15, and ASTM A-536, Grade 65-45-12 Vic Flange Adapters: Vic Style 744, Class 150 or Style 743 Class 300 Ductile Iron, conforming to ASTM A 395, Grade 65-45-15, and ASTM A -536, Grade 65-45-12. Where Seismic Design requirements apply, use Victaulic Installation Ready Style 177 and Style 77 or 75 Couplings in accordance with the latest Victaulic Installation Instructions.

D. Fittings Not Allowed: Fittings that incorporate the use of a set screw or bolt tightened against a section of piping such as manufactured by J.B. Ward or Victaulic F.I.T. shall not be used. Additional fittings, couplings, etc. that are not approved include, but are not limited to, the following:

1. Press Fit Piping Systems and Fittings
2. Plain End Piping Systems and Fittings

3. Snap on fittings. Example: Vic Style 925 Snap Let Outlet or Vic Style 791 Boltless Couplings
4. Strapless type fittings. Example: Vic Style 78 Snap Joint Coupling or couplings secured to the piping with U-Bolts
5. Tongue and Recess Style Couplings

E. Sprinkler Head Drops: In lieu of rigid pipe offsets or return bends for sprinkler drops, a flexible Stainless Steel Sprinkler Fitting System, as manufactured by Victaulic or approved equal, may be used to locate sprinklers in the ceiling tiles or in walls where indicated on the installation drawings. The system shall comply with the following:

1. Approvals: FM-1637 (Braided) or UL 2443. The sprinkler fitting system shall be listed or approved for installation in a suspended acoustical ceiling or hard ceiling system.
2. Mounting Bracket: Victaulic style AB mounting bracket shall be a one (1) piece tubular steel bracket and metal anchors suitable attachment to the ceiling support system. The bracket shall be anchored into the ceiling with a screw for a permanent installation. No wing nut style brackets will be allowed.
3. Hoses: Victaulic style AH flex hoses shall be a one (1) inch ID braided hose with a two (2) inch minimum bend radius and hydraulically calculated with a minimum of four (4) 90 degree bends. Hose length shall be limited up to forty eight (48) inches.
4. Labels: A tamper resistant label shall be installed on the bracket ends to prevent relocation of the heads.
5. Commissioning: A factory representative shall be on site to verify the system has been properly installed prior to final connections to the sprinkler heads.

2.3 VALVES

A. General: Valves shall be approved types and as specified in NFPA 13 and the U.L. All valves controlling fire protection water supplies shall be Outside Stem and Yoke (OS&Y). Butterfly valves shall be used only in areas where OS&Y Valves cannot be installed.

B. OS&Y Valves: OS&Y Valves shall be by Victaulic Series 771H Groove by Groove or Series 77iF Groove by Flange Pressure Rated up to 200 PSI, with ductile iron body (ASTM – 536), EPDM Body Gaskets, Steel Nuts and Bolts, and Cast Iron Hand Wheel (ASTM 126 – B) or approved equal by Grinnell, Viking Stockham, Muller, or Nibco.

C. Butterfly Valves: Butterfly Valves shall be Victaulic Series 705, Pressure Rated up to 300 PSI with Ductile Iron Body and Disc (ASTM – 536) EPDM pressure responsive seat, Teflon impregnated fiberglass with stainless steel backing Stem Bearings, EPDM O Ring, Carbon Steel Plated Tap Plug, Bracket and Weatherproof Actuator or approved equal by Grinnell, Viking, Stockham, Muller, or Nibco. The valve stem shall be offset from the disc centerline to provide complete 360 degree circumferential seating.

D. Trim and Drain Valves: Trim and drain valves include ball valves, globe valves and plug valves. Trim and Drain Valves installed as part of an automatic sprinkler system or fire protection standpipe shall have a minimum pressure rating of 175 PSI and be listed for use as part of a fire protection system by U.L.'s "Fire Protection Equipment Directory" or FM Global's "Approval Guide." Automatic (ball drip) drain valves shall comply with U.L. 1726. Ball drip valves shall be minimum NPS three-quarters (3/4) inch with threaded connections.

E. Check Valves: Provide check valves where required as follows:

1. Alarm Check Valve: An approved Alarm Check Valve (variable pressure type) with all appropriate trimmings shall be installed on the system side of the water supply control valve. Alarm Check Valves shall be by Victaulic Series 751, with a High Strength Ductile Iron Body (ASTM A-536 Grade 65-45-12), Aluminum Bronze Clapper, Stainless Steel Shaft – 17-4, EPDM Clapper Seal (ASTM D2000), Nitrile Seat O Rings, Stainless Steel Springs, and all necessary trim for a complete assembly, Pressure Rated up to 300 PSI or approved equal. The valves internal components shall be replaceable with the valve in the installed position. The top of the retard device or alarm line shall be fitted with an approved pressure switch Reliable Model 'G', Type 1, or equivalent. Conductors shall be provided under the electrical section to provide fire alarm and annunciation. Activation of the sprinkler system by one sprinkler or equivalent test shall cause the fire alarm system to activate and the appropriate lamp(s) to activate on the annunciator as "Main Water Flow".
2. Swing Check Valves: Swing-type Check valves shall comply with U.L. 312 rated up to 300 PSI with Cast Iron Body. Subject to compliance with requirements, provide Check Valves manufactured by Grinnell, Viking, Stockham, Muller, or Nibco.

2.4 CABINETS

A. Fire Protection Valve Cabinet: Provide and install where indicated on drawing Potter-Roemer Fig. No. 1810 recessed Fire Dept. Valve Cabinet with 20 gauge tubular steel door, and 18 gauge frame.

B. Sprinkler Cabinet: Provide a Metal Sprinkler Cabinet equipped with a supply of spare sprinklers. The spare sprinklers (not less than six of each type) shall correspond with each type of sprinkler and temperature rating that was installed in the project. Provide the necessary wrench(s) for each of the type sprinkler installed. The cabinet shall be a red baked enamel steel box by Potter Roamer Figure 6162, Victaulic or equal.

2.5 PRESSURE GAUGE

A. Pressure gauges shall comply with U.L. 393. Dials shall be three and one half (3-1/2) inches to four and one half (4-1/2) inches in diameter. Pressure gauge shall range from 0 to 300 PSI. Water system piping gauges shall include “WATER” or “AIR/WATER” label on dial face. Air system piping gauge shall include retard feature and “AIR” or “AIR/WATER” label on dial face.

2.6 HANGERS

A. All pipe hangers and hanger spacing shall be in strict accordance with NFPA 13.

2.7 SPRINKLERS HEADS

A. General: Sprinkler heads shall be listed by Underwriter's Laboratory and only new sprinkler heads shall be installed. Any sprinkler head that incurs damage, is painted or sprayed with any fire retardant material or other restrictive material before the system is accepted by the University, shall be replaced by the contractor at no cost to the Owner. Sprinkler heads shall be provided and installed in accordance with NFPA 13, and properly coordinated with other work. The correct sprinkler head type shall be used in every location.

B. Temperature Ratings: The correct temperature rating of every sprinkler head used shall be according to the maximum ceiling temperature rating and requirement according to the table in NFPA 13. All sprinkler heads (when required) shall have their frames colored coded with the special protective coatings applied by the manufacturer.

C. Sprinkler Head Type: Sprinklers shall be glass bulb type with hex shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation. Wrenches shall be provided by the sprinkler manufacturer that directly engages the cast wrench boss.

1. Basis of Design shall be Sprinkler Heads manufactured by Viking and/or Tyco as indicated.
2. Other Acceptable Manufacturer shall be Sprinkler Heads manufactured by Victaulic where indicated.

D. Sprinkler Head Guards: Sprinkler heads that may be subject to damage due to their location under stairwells, or low hanging sprinklers in Corridors, Storage Rooms,

Mechanical Equipment Rooms or under ducts shall be provided with Guards manufactured by the sprinkler company.

E. Spare Stock: A stock of spare sprinkler heads and appropriate wrench(s) shall be turned over to the University at the final acceptance testing. The stock of spare sprinklers shall be cabinet mounted and shall include all types and temperature ratings installed for this project. The number of spare sprinkler heads shall correspond to the requirements of NFPA 13 for each type and rating.

F. Coverage: Except for High Hazard Areas, Sprinkler heads shall be Standard Coverage type heads with a 'K' Factor of 5.6, unless modified by the following:

1. Exposed Sprinkler Heads: Where sprinkler piping is exposed use Viking Microfast Model 'VK300' or Victaulic Model V27 Quick Response 165ºF upright-type sprinkler heads.
2. Dry Pipe System Sprinkler Heads: Where dry sprinkler system protection is required use Viking Model Commercial Quick Response 165ºF Dry pendent sprinkler heads, adjustable as required.

2.8 DRY PIPE SPRINKLER SYSTEMS

A. Provide a Dry Pipe Valve Assembly, Victaulic Series 768NXT, Pressure Rated up to 300 PSI or approved equal with all the required trimmings.

B. All required Piping, Fittings, Joints, Valves etc. shall be as hereinbefore specified.

C. Dry Pipe Compressor System Components: Include the following:

1. Compressor:

a. Provide air cooled, single-state compressor with heavy balanced cast iron flywheel.
b. Pressure shall be up to 100 P.S.I.G. intermittent.
c. Lubrication shall be splash lubricated from dippers on connecting rods.
d. Air filters: pad type shall be built internally into cylinder head and are easily removed for cleaning or replacement.
e. Bearings shall be heavy-duty bronze journal bearings, extra large for long life.
f. Crank shafts shall be heavy-duty, machined and ground with integral counterweights.
g. Connecting Rods shall be aluminum alloy with extra large bearings.

h. Crankcases shall be cast iron with integral cast mounting feet. There is no gasket joint below oil level line. Units are equipped with duct tight breather valves.
i. Cylinders shall be iron alloy, precision bored and honed. Castings shall have deep cooling fins and shall be separate from crankcase to permit replacement.
j. Pistons shall be automotive type with two (2) compression and one (1) oil control ring. Hardened and ground piston pins.
k. Cylinder heads shall be cast iron with deep cooling fins.
l. Valves shall be replaceable disc type with hardened guides on single cylinder and high efficiency reed type, three (3) intake and three (3) discharge reeds per cylinder) on two (2) & four (4) cylinder units.
m. Oil level dip stick on two (2) & four (4) cylinder units. Visual on single cylinder unit.

2. Electric Motors: Provide NEMA type motors rated for continuous duty. Open, drip-proof motors with 1.25 service factor on fractional horsepower and 1.15 service factor on integral horsepower. Motors shall be dual voltage rated.

3. Air Receivers: Include the following:

a. Tank mounted unit shall be built to ASME specifications and National Board certified. Equipped with pressure gauge and ASME safety valve.
b. Provide an approved automatic air maintenance device for each system. Automatic Air Maintenance Device shall be Victaulic Series 757 Air Maintenance Trim Assembly with regulator, or approved equal, for each Dry Valve Assembly.

4. Belt Guard: Provide totally enclosed steel belt guard providing maximum operating safety. Louvered to allow flow of cooling air over compressor pump. Easily unbolted front cover for belt replacement.

5. Drive: V-belt drive shall be designed for high load factor. Properly aligned for quiet continuous and efficient service.

6. Check Valve: Units shall be equipped with quiet operating check valve.

7. Aftercooler: Units shall have large diameter copper discharge line to deliver cooler air to air receiver.

8. Air Pressure Switch: Units shall be equipped with heavy-duty NEMA 1 adjustable pressure switch. Pressure switch shall be equipped with unloader valve to allow for a loadless start.

2.9 PRE-ACTION SYSTEMS: SUPERVISED SINGLE INTERLOCK TYPE WITH ELECTRIC ACTUATION

A. Provide all the components required by NFPA for a complete pre-action sprinkler system. The equipment shall include a deluge style automatic control valve with trim and all equipment required for electric release. All components must be UL and FM listed and approved by NFPA for use in a pre-action system.

B. The automatic control valve shall be a right angle style that is able to be reset without opening the valve. The release line shall be equipped with a hydraulic device preventing the valve from resetting until the system is manually reset. The valve shall be UL and FM listed and approved by NFPA for use in pre-action systems and compatible with the releasing equipment. The automatic valve shall be as manufactured by Victaulic, NXT Series 769 or approved equal. Include the following:

1. Pre-action valve clappers shall incorporate a latching mechanism that will not be affected by pressure changes in the water system.
2. In addition to automatic operation, arrange each valve for manual release at the valve.
3. Provide pressure gages and other appurtenances at the pre-action valves.
4. Provide a test detection device for each actuation circuit adjacent to each valve which the device controls as required by NFPA 13.

C. The release control panel shall be UL and FM listed and approved by NFPA for use in pre-action systems and compatible with the releasing solenoid. The detection system shall be compatible with the release control panel and listed for use in pre-action systems. The panel shall be programmable for crossed zoned detection from dip switch settings on the front of the mother board. The panel shall include supervised contacts for detection zones and signaling requirements per NFPA. Extra supervisory contacts shall be provided by a factory installed module with three alarm, two supervisory, and one trouble contact. The release control panel shall be a Model B-1, PDRD 2001, as manufactured by Victaulic or approved equal.

1. Battery & Charger System: Include the following:

a. Self contained batteries mounted within main control panel.
b. Rated for twenty four (24) hours of non-alarm monitoring plus five (5) minutes of alarm conditions.
c. Sized for 120% of Amp-Hour requirement per calculations.
d. Sealed lead acid type, maintenance free.
e. Minimum projected life of five (5) years.
f. Automatic operation upon loss of primary power.
g. Solid state automatic transfer switch to switch to battery power if the normal AC input voltage falls below 15% of nominal. The audible system

trouble tone shall sound upon loss of AC input, and "LOSS OF AC POWER" message shall be displayed.

h. Automatic, variable rate battery charger: Include the following:

1) Capacity for 150% of the connected system load while maintaining batteries fully charged.
2) Capable of recharging batteries from fully discharged to fully charged in four (4) hours.
3) Fully supervised charger output.

D. The pre-action system shall be single interlocked. The operation of the detection system is required in order to open the valve; precharging the sprinkler pipe before a sprinkler operates. Air supervisory pressure shall monitor the integrity of the piping system. Loss of supervisory pressure shall indicate an alarm but the system control valve shall not open.

E. Pressure Switch: Provide switch with circuit opener or closer for the automatic transmittal of an alarm over the facility fire alarm system. Connect into the building fire alarm system. Alarm actuating device shall have mechanical diaphragm controlled retard device adjustable from ten (10) to sixty (60) seconds and shall instantly recycle.

F. Tank Mounted Air Compressor: Provide an approved, automatic type, electric motor driven air compressor with 38oF dew point air dryer, including pressure switch, air piping, and ten (10) gallon minimum capacity tank. Compressor shall have a minimum capacity capable of charging the complete sprinkler system to normal system air pressure within thirty (30) minutes while continuously delivering 38°F dew point air. Provide an approved automatic air maintenance device for each system. Automatic Air Maintenance Device shall be Victaulic Series 757 Air Maintenance Trim Assembly with regulator, or approved equal, for each Dry Valve Assembly.

G. Supervision: Pre-action sprinkler piping and pneumatic detection system and pre-action valve electric releases shall be supervised. A break in the piping or tubing systems resulting in loss of pneumatic pressure shall activate trouble alarm. Provide a silencing switch which transfers trouble signals to an indicating lamp; arrange so that correction of the trouble condition will automatically transfer the trouble signal from the indicating lamp back to the trouble alarm until the switch is restored to normal position.

H. Heat Detectors: Include the following:

1. Fixed Temperature Heat Detector.
2. Base with twist lock mounting.
3. Construction to prevent insect and dust entry.
4. Corrosion and vibration resistant.
5. Screw terminal wiring connections.
6. Fusible alloy thermal element.

7. Low profile, one and three eighth (1-3/8) inches from ceiling.
8. Element drops one (1) inch to indicate detector operation.
9. Replaceable elements without disassembling detector.
10. Temperature rating 135ºF, coordinated with sprinkler rating.

I. System Wiring: Include the following:

1. Solid copper conductors, #16 AWG minimum unless otherwise required by the system manufacturer.
2. PVC insulation, minimum 900C rated.
3. Single or multiconductor type.
4. UL Listed.
5. Compliant with NEC Art. 760.
6. Installed in EMT conduit, or type MC Cable.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Install all pipe, fittings, valves, controls, and hangers as required in accordance with NFPA 13.

B. The work under this contract shall be coordinated with that of all trades so that all work may be installed in the most direct and workmanlike manner and so that interference between piping, ducts, equipment, architectural and structural features will be avoided.

C. The sprinkler contractor shall install water flow alarms, valve supervisory devices, and any other sprinkler system equipment designed to be electrically interconnected into a fire alarm system but shall not inter- connect to the fire alarm system.

D. All electrical devices incorporating electrical apparatus installed by the sprinkler contractor as part of the sprinkler system shall be interconnected electrically under another section of these specifications.

E. Connection(s) shall be made to an approved water supply capable of delivering the necessary volume. The connection between the system piping and underground piping shall be made with a cast iron flanged piece, properly fastened.

3.2 PIPING

A. All Piping shall be run concealed in areas with suspended ceilings. Piping shall be installed and arranged to protect it from freezing and corrosion, and shall be pitched for drainage. Installation of all piping shall be in coordination with ducts, light fixtures, and any other work that may obstruct sprinklers.

B. All sprinkler piping shall be substantially supported from the building structure which must support the added load of water filled pipe plus a minimum of two hundred fifty (250) pounds applied at the point of hanging in accordance with NFPA 13.

C. All underground piping shall be rodded for the entire underground run. The rodding shall continue through the wall and into the building being protected and terminate at the interior system connection. Pillow blocks shall be installed at each change of piping direction and properly placed so as to prevent the lateral movement of the pipe.

D. Piping shall be installed and arranged so as to be protected from freezing, corrosion, and shall have the correct pitch for drainage. Installation of all piping shall be coordinated with the installation of ducts, light fixtures, ceiling grids, and all other work that may obstruct sprinklers.

E. All risers, including the alarm check valve, shall be equipped with drains sized as specified in NFPA 13. The alarm check valve drain (main drain) shall be piped to the outside of the building or to a Storm Water Sump with Pumps approved for the purpose by the Engineer and the UMB Fire Marshall. A supplementary drain of equal size shall then be provided for test purposes with free discharge, located at or above grade. An extra valve shall be installed in the line to the sump in order to close the line during tests.

3.3 PIPE JOINTS

A. Grooved Joints: Install in accordance with the manufacturer's latest published installation instructions. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to (and including) groove. Gasket shall be manufactured by the coupling manufacturer and verified as suitable for the intended service. A factory trained representative (direct employee) of the coupling manufacturer shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation. The representative shall periodically visit the job site and review installation to ensure best practices in grooved joint installation are being followed. Contractor shall remove and replace any improperly installed products.

3.4 DRAINS AND TEST PIPING

A. Drains and test piping shall be furnished and installed so that all parts of the fire protection system may be drained and tested properly. Piping shall not be exposed to freezing (except approved dry pipe systems).

B. All interior sectional control valves, including riser control valves, shall be provided with auxiliary drainage so located as to drain that portion of the system controlled by the section al control valve. These sectional auxiliary drains shall be piped as indicated in paragraph 3.2.D.

C. Auxiliary drains shall be provided to properly drain all low points of the system when a change in direction prevents drainage through the main system.

D. All Sprinkler System drain piping, including main drain, each riser drain, all sectional auxiliary drains shall be piped individually or combined into one or more common drain pipes which are piped to the sanitary or storm drain system. Where the drain piping cannot be piped to a Lower Level Mechanical Equipment Room the drain piping shall be combined into one or more sectional drains and piped to hose bibs located on the exterior of the building. Provide a sign at each hose bib that reads "SPRINKLER SYSTEM DRAIN". The location of these hose bibs and signs must be coordinated with the UMB A/E Staff and the UMB – FM.

3.5 SPRINKLER HEADS

A. Where rigid pipe offsets, return bends or flexible fitting systems are used for the sprinkler drop, the connection to the drop must be off of the top of the main or branch pipe.

B. Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.

C. Sprinkler bulb protector shall be removed by hand after installation. Do not use tools or any other device(s) to remove the protector that could damage the bulb in any way.

3.6 SPRINKLER CABINET

A. The reserve sprinkler cabinet shall be surface mounted and installed on a wall adjacent to the main sprinkler controls for the fire pump, if provided. In buildings were there is no fire pump coordinate the location the new sprinkler cabinet with UMB A/E Staff and UMB - FM.

B. Provide a sign for the new sprinkler cabinet that reads "NEW SPRINKLER HEAD CABINET - DATE INSTASLLED - MO- DAY-YR".

3.7 INSPECTORS TEST CONNECTION

A. The inspectors test shall be installed in the top level of a sprinkler system and discharged into an approved drain discharge system.

B. In multi-storied buildings where water flow alarms are provided at each riser on each floor, or where more than one alarm device is provided at each riser on each floor, or where more than one alarm device is provided in one sprinkler system, an inspector's test device shall be provided for testing each alarm device.

3.8 VALVES

A. Provide at least one approved valve in each source of water supply except the fire department connection(s).

B. Provide approved indicating valves at the base of each major riser, unless there is only one riser.

C. Provide approved indicating valve on the supply side of the alarm check valve.

D. Provide approved indicating valves to control each floor or zones of sprinkler protection on each floor.

E. All valves controlling water supply for the sprinkler system shall be installed so that they may be readily accessible for use by emergency and maintenance personnel.

F. Drain and test valves shall be of approved types and in accordance with NFPA 13.

G. Drain and auxiliary valves shall be of an approved type and in accordance with NFPA 13 edition. Drain and auxiliary drain valves shall be either globe or angle valves as required and readily accessible for maintenance personnel.

H. Provide a supervised valve(s) for local control for each elevator machine room. Locate the valve outside of the room in an accessible location. Where local control valves are located above a ceiling provide a access door in hard ceilings and a sign mounted on the wall below the valve location. The sign should read “Local Sprinkler Control Valve”.

3.9 HOLE SAW DISCS

A. If the contractor is required to make openings in the piping by means of a hole saw, the contractor shall remove the resultant discs (slug) and hang the discs adjacent to the hole cut. Failure by the contractor to do this will result in the contractor completely disassembling the sprinkler system to satisfy the engineer that the discs is not in the system piping.

3.10 DUST, SOIL, DEBRIS

A. The contractor shall take such steps as necessary to protect the surface and contents of rooms in which work is in operation, from damage from his/her operation. The room contents shall be either moved out of the way or covered with waterproof coverings while work is in progress. The contractor shall remove and replace ceilings and protect them against dirt and damage.

B. Particular care shall be exercised to prevent staining damage from cutting oils used in the cutting and threading of pipe.

C. Suitable non-permeable drop cloths shall be used under all cutting and threading machines.

D. The contractor will be held responsible and accountable for any damage resulting from his/her operation.

3.11 CONNECTIONS AND ALTERATIONS TO EXISTING WORK

A. When the new work under this project requires connection to existing piping, rearranges existing piping, etc., the contractor shall perform all necessary cutting, fittings, etc., to the existing work as may be necessary or required to make satisfactory connections between the new work, as to leave the entire completed work finished in a workmanlike manner to the entire satisfaction of the Engineer.

B. The contractor shall make the necessary arrangements with the engineer for all outages of utilities or fire protection systems. Such outages shall be made at least five (5) days in advance of the anticipated outage requirement.

3.12 CUTTING AND PATCHING

A. The cutting of walls and floors for passage and accommodation of new piping, the closing of openings and removal of all debris caused by the work under this contract shall be performed by and at the expense of the contractor.

B. Patching shall be uniform in appearance and shall match the surrounding surfaces. New openings in existing C.M.U. floors shall be drilled with diamond core drills.

C. Building surfaces cut, damaged or removed in the performance of work under this contract shall be repaired as close to their original condition.

3.13 INSTALLATION, TESTS, AND ACCEPTANCE

A. Installation, testing, and final acceptance shall be in accordance with all applicable codes, and authorities having jurisdiction.

B. For pressure test requirements see Division 21 Specification Section “Leak Test Fire Protection Piping Systems”.

3.14 DOCUMENTATION

A. The following documentation shall be furnished to the University by the contractor at the conclusion of the final acceptance test:

1. Operating and maintenance instructions of controllers, alarm valves, etc. as required by NFPA 13.
2. The spare sprinklers hereinbefore specified and wrench(s).

3. A copy of NFPA 25 Water-Based Fire protection Systems.

3.15 DEMONSTRATION OF SPRINKLER AND STANDPIPE SYSTEMS

A. Demonstrate equipment, specialties, and accessories. Review operating and maintenance information.

B. Schedule demonstration with at least seven (7) days advance notice.

3.16 DRY PIPE SYSTEMS

A. The installation for dry pipe sprinkler systems shall comply with the foregoing specifications, except where specifically modified in NFPA 13 for dry pipe sprinkler systems.

B. The connection from the fire department siamese shall be made from the system side of the main control valve and on the supply side of the dry pipe alarm check valve.

C. Auxiliary drains shall consist of a one half (1/2) inch valve with nipple and cap for under five (5) gallons capacity of trapped and two (2), one (1) inch valves with two (2) inch by twelve (12) inch nipple or equivalent for over five (5) gallons. Tie in drains shall be minimum one (1) inch.

D. Installation, location, and protection of dry pipe sprinkler systems shall be in accordance with NFPA 13. The required continuous air compressor and heater (s) shall be connected to an emergency electrical power source.

E. Sufficient OS&Y Valves and Check Valves shall be provided so that either pump can be isolated for inspection and service.

F. An approved dry pipe valve with all the trimmings shall be installed on the system side of the main water valve. All equipment shall be located and installed so that it is accessible for inspection, removal and repair and shall be substantially supported.

3.17 PRE-ACTION SYSTEM – FIELD WIRING

A. Under this Section, provide all wiring of heat detectors ad pre-action control in accordance with NEC, NFPA, and Electrical Specifications, and as herein specified.

B. Pre-action system wiring shall include:

1. Initiating device circuits (IDC).
2. Miscellaneous control wiring.

C. Installation of fire alarm wiring:

1. Install all wiring in conduit.
2. Identify conduit and boxes with red paint at regular intervals. (all boxes and every 8-10 LF).
3. MC Cable may be used in lieu of EMT.
4. Do not mix fire alarm wiring with wiring of any other system.
5. Use distinctive color coding for insulation.

    a. Distinct from all power wiring colors.
    b. Different colors for IDC, NAC and SLC wiring.

D. System Supervision:

1. NFPA Class B, (Style B).
2. Wiring supervised for open circuits and grounds.
3. Open or ground shall cause Trouble signal.
4. System shall be capable of alarm signal receipt during a single ground fault condition.
5. Each alarm and trouble LED shall be supervised.

END OF SECTION 211313

SECTION 220000 – BASIC MECHANICAL REQUIREMENTS – PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 22.

1.2 SUMMARY

A. This Section includes the requirements for the following:

1. Codes, organizations, standards, and abbreviations
2. Submittals
3. Site Visit
4. Outages
5. Variances
6. Cutting, welding and burning
7. Performance requirements
8. Material and equipment
9. Related work
10. Contract drawings
11. Coordination
12. Demolition
13. Fire safe materials
14. UL requirements
15. Construction record documents.
16. Operation and maintenance manuals
17. Fire stops and smoke seals
18. Guarantee / Warranty
19. Pipe and supports
20. Equipment roughins
21. Cutting and patching
22. Installation requirements common to equipment specification sections
23. Excavation and back fill
24. Temporary service
25. Demonstrations
26. Final cleaning

1.3 CODES, ORGANIZATIONS, STANDARDS AND ABBRIVIATIONS

A. The following list of codes, organizations, standards and abbreviations are utilized within Division 22 Specification Sections and are provided as a reference.

B. Codes: All material and equipment provided and installed as part of these construction documents shall be in compliance with the latest edition of the following codes as adapted by the State of Maryland for the following codes:

1. IBC: International Building Code
2. IMC: International Mechanical Code
3. IECC: International Energy Conservation Code
4. NEC: National Electrical Code
5. NFPA: National Fire Protection Association
6. PHCC: National Standard Plumbing Code Illustrated

C. Organizations and Standards: The list of organizations and standards are as follows:

1. ADA: American National Standards Institute
2. AGA: American Gas Association
3. ANSI: American National Standards Institute
4. ASHRAE: American Society of Heating Refrigeration and Air Conditioning Engineers
5. ASME: American Society of Mechanical Engineers
6. ASSE: American Society of Safety Engineers
7. ASTM: American Society for Testing and Materials
8. AWS: American Welding Society
9. AWWA: American Water Works Association
10. CDA: Copper Development Association Inc.
11. CFR; Code of Federal Regulations
12. CGA: Compressed Gas Association
13. CISPI: Cast Iron Soil Pipe Institute
14. CS: Commercial Standard
15. CSA: Canadian Standards Association
16. EJMA: Expansion Joint Manufacturers Association
17. EPA: Environmental Protection Agency
18. FDA: Food and Drug Administration
19. IAPMO: International Association of Plumbing and Mechanical Officials
20. IBC: International Building Code
21. IBR: Institute of Boiler and Radiator Manufacturers
22. ICC: International Code Council
23. IEEE: Institute of Electrical and Electronics Engineers
24. LED: Light Emitting Diode
25. MFMA: Metal Framing Manufacturers Association
26. MOSHA: Maryland Occupational Safety and Health Administration
27. MSS: Manufacturers Standardization Society
28. MSS SP: Manufacturers Standardization Society Standard Practice
29. NEMA: National Electrical Manufacturers Association
30. NEMA MG: National Electrical Manufacturers Association Motors & Generators
31. NFPA: National Fire Protection Association
32. NICET: National Institute for Certification in Engineering Technologies

33. NSF: National Sanitation Foundation
34. NRTL: Nationally Recognized Testing Laboratory
35. OSHA: Occupational Safety and Health Administration
36. OSHPD: Office of Statewide Health Planning and Development
37. PDI: Plumbing and Drainage Institute
38. SEI: Software Engineering Institute
39. SSPC: Society for Protective Coatings
40. UB: University of Baltimore
41. UL: Underwriters' Laboratories
42. UM: University of Maryland
43. UMB: University of Maryland, Baltimore
44. UMB-A/E: University of Maryland, Baltimore – Architect/Engineer
45. UMB-FM: University of Maryland, Baltimore – Facilities Management
46. UMB-PM: University of Maryland, Baltimore – Project Manager
47. UMBC: University of Maryland, Baltimore County

D. Abbreviations: The list of abbreviations are as follows:

1. AEC: Architecture, Engineering and Construction
2. ASJ: All Service Jacket
3. AWF: All Weather Finish
4. AWG: American Wire Gauge
5. CAD: Computer Aided Design
6. CD-ROM: Compact Disk – Read Only Material
7. CM: Construction Manager
8. CWP: Cold Working Pressure
9. ºC: Degree Celsius
10. ºF: Degree Fahrenheit
11. Dwg: Drawing
12. DOC: Document
13. Dwg: Drawing
14. EPDM: Ethylene Propylene Diene Terpolymer Rubber
15. FNPT: Female National Pipe Thread
16. FSK: Foil-Scrim-Kraft
17. FT: Foot, Feet
18. GC: Glass Cloth
19. GPH: Gallons per Hour
20. HCFC: Hydrochlorofluorocarbons
21. HNBR: Hydrogenated Nitrile Butadiene Rubber
22. HP: Horse Power
23. HVAC: Heating Ventilation and Air Conditioning
24. Hz: Hertz
25. ID: Inside Diameter
26. IEQ: Indoor Environmental Quality
27. IN: Inches
28. Lb/ft: Pound-Foot

29. LED: Light Emitting Diode
30. LF: Linear Feet
31. LLDPE: Linear Low Density Polyethylene Resins
32. MAX: Maximum
33. MER: Mechanical Equipment Room
34. MIN: Minimum
35. N/A: Not Applicable
36. NBR: Acrylonitrile-Butadiene, Buna-N, or Nitrile Rubber
37. NOM: Nominal
38. NPS: Nominal Pipe Size
39. NPT: National Pipe Thread
40. NRS: Nonrising Stem
41. OD: Outside Diameter
42. OS&Y: Outside Screw and Yoke
43. Pdf: Portable Document Format
44. PE: Polyethylene
45. PSI: Pounds per Square Inch
46. PSIG: Pounds per Square Inch Gage
47. PVC: Polyvinyl Chloride
48. RS: Rising Stem
49. UV: Ultraviolet
50. V: Volt
51. VAC: Vacuum
52. VOC: Volatile organic compounds

1.4 SUBMITTALS

A. General: For general requirements see Architectural Specification Division 01 Section "Submittals".

B. CHANGE THE NUMBER OF ADDITIONAL COPIES INDICATED BELOW TO SUIT OFFICE PRACProvide submittals for all material, equipment and/or supports as specified in Division 22 and where indicated on the drawings and details. For material and CHANGE THE NUMBER OF ADDITIONAL COPIES INDICATED BELOW TO SUIT OFFICE PRACproduct data submission requirements see Division 22 Specification Sections. At a minimum the following submittals shall be provided as required by the project:

1. Pipe, fittings and accessories for each system.
2. Valves, strainers and unions for each system.
3. Insulation.
4. Hangers and supports.
5. Plumbing fixtures and trim.
6. Identification labels and tags.
7. Floor drains.
8. Hot water heating equipment.

9. Trap priming system.
10. Backflow preventers.
11. Pipe and supports.

C. Submittal File Format: File formats for each submittal shall be electronically as follows:

1. Product Data: “pdf” file format.
2. Shop Drawings: “pdf” file format.
3. Coordinated Drawings: “pdf” or “dwg” file formats.
4. Schedules: “xl” file format.

1.5 SITE VISIT

A. Prior to preparing the bid, the mechanical plumbing subcontractor shall visit the site and become familiar with all existing conditions. Make all necessary investigations as to locations of utilities and all other matters which can affect the work. No additional compensation will be made to the contractor as a result of his failure to familiarize himself with the existing conditions under which the work must be performed.

1.6 OUTAGES

A. For all work requiring an outage, the mechanical/plumbing contractor shall submit an outage request to the UMB Project Manager, using the UMB Standard Request for Outage Form which is available through the UMB Design and Construction Web Site at http://www.umaryland.edu/designandconstruction/, under the Documents Link. The existing plumbing system shall remain operational unless turned off by University personnel during the construction of the project.

B. Unless otherwise specified, outages of any services required for the performance of this contract and affecting areas other than the immediate work area shall be scheduled at least ten days (10) days in advance with the Office of Facilities Management. All such outages shall be performed on other than normal duty hours.

C. All plumbing outages which will interfere with the normal use of the building in any manner shall be done at such times as shall be mutually agreed upon by the contractor and the Office of Facilities Management.

D. The plumbing contractor shall include in his price the cost of all premium time required for outages and other work which interferes with the normal use of the building, which will be performed, in most cases, during other than normal work time and at the convenience of the University.

E. The operation of plumbing valves or switches; required to achieve an outage must be accomplished by University personnel only. Prospective subcontractors under this section

are cautioned that the unauthorized operation of plumbing valves, power switches, or other control devices by their personnel can result in extremely serious consequences for which the contractor will be held accountable.

1.7 VARIANCES

A. Where variances occur between the drawings and specifications or within either document itself, the item or arrangement of better quality, greater quantity or higher cost shall be included in the contract price. The Engineer shall decide on the item and manner in which the work shall be provided.

1.8 CUTTING, WELDING, BURNING

A. Before the contractor and/or any sub-contractor commences any cutting, welding, burning, brazing (pipe sweating), the contractor shall obtain a hot work permit from Environmental Health and Safety at extension 1-410-706-7055.

B. The hot work permit copy shall remain on the job site at the hot work location until such work is completed at which time the permit shall be returned to Environmental Health and Safety.

1.9 PERFORMANCE REQUIREMENTS

A. Contract drawings are generally diagrammatic and do not indicate all offsets, fittings, transitions, access panels and other specialties required. Furnish and install all items as may be required to fit the work to the conditions encountered.

B. Arrange plumbing piping, equipment and other work generally as shown on the contract drawings, providing proper clearances and access.

C. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawing submittal for approval in accordance with Submittals specified below.

D. The Architect may make reasonable changes in location of equipment piping and ductwork up to the time of rough-in or fabrication.

1.10 MATERIALS AND EQUIPMENT

A. The contract drawings and system performances have been designed on the basis of using the particular manufacturer’s products specified or scheduled on the contract drawings.

B. Products of other manufacturer’s listed in the specification shall be permitted provided as follows:

1. Products meet all of the requirements of the specifications.

2. Make, without additional cost to the Owner, all adjustments for deviations, such that the final installation is complete and functions as the basis of design product is intended.

C. Products with dimensions or other characteristics different from the basis of design product that render their use impractical or cause functional fit, access, or connection problems, shall not be acceptable.

1.11 COORDINATION, SEQUENCING AND SCHEDULING

REVISE ITEMS IN THE FOLLOWING EXAMPLES TO COVER PROJECT REQUIREMENTS.

A. Coordination: Coordinate plumbing systems, equipment, and materials installation with other building components.
B. Utilities: Coordinate connection of plumbing systems with exterior underground services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

C. Chases: Arrange for chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

D. Sleeves: Coordinate the installation of required supporting devices and set sleeves in poured in place concrete and other structural components as they are constructed.

E. Sequencing: Sequence, coordinate, and integrate installations of plumbing material and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.

F. Electrical Services: Coordinate connection of electrical services.

G. Access: Coordinate requirements for access panels and doors where mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Architectural Specification Section "Access Doors."

H. Scheduling: Schedule and coordinate the delivery of material and equipment with other trades to avoid delivery conflicts.

1.12 DEMOLITION

A. Plumbing Demolition: REVISE ITEMS IN THE FOLLOWING EXAMPLES TO COVER PROJECT REQUIREMENTS.
A. Not applicable.

1.13 FIRE SAFE MATERIALS

A. Unless otherwise indicated, materials shall conform to UL, NFPA or ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of twenty five (25) and smoke development of fifty (50).

1.14 UNDERWRITER'S LABORATORY (UL) REQUIREMENTS

A. All equipment containing electrical components and provided as part of the mechanical specifications shall bear the Underwriter's Laboratory (UL) label, as a complete packaged system.

1. Equipment not provided with a UL label shall be tested in the field, certified and provided with a UL label at the installer's expense.
2. Field testing shall be performed by a testing agency approved by the authority having jurisdiction.

1.15 CONSTRUCTION RECORD DOCUMENTS

A. The mechanical/plumbing contractor shall maintain a set of construction record documents during the construction period in accordance with Specification Division 01 Section "Project Closeout".
REFER TO DIVISION 1 SECTION "PROJECT CLOSEOUT," TEXT AND EVALUATIONS, FOR GENERAL REQUIREMENTS BEFORE EDITING THIS ARTICLE. SPECIFY ONLY MECHANICAL-RELATED REQUIREMENTS HERE.

1.16 OPERATION AND MAINTENANCE MANUALS

A. Prepare one (1) electronic maintenance manual file in "pdf" format in accordance with Specification Division 01 Section "Project Closeout."
REFER TO DIVISION 1 SECTION "MATERIALS AND EQUIPMENT," TEXT AND EVALUATIONS, FOR GENERAL REQUIREMENTS BEFORE EDITING THIS ARTICLE. SPECIFY ONLY MECHANICAL-RELATED REQUIREMENTS HERE.

1.17 FIRE STOPS & SMOKE SEALS

A. Fire stops and smoke seals shall be provided by one (1) manufacturer for all trades. See Architectural Specification Division 07 for requirements.

1.18 WARRANTY/GUARANTEE

A. All materials, equipment, etc. provided by the general contractor and/or his subcontractors shall be warranted and guaranteed to be free from defects in workmanship and materials for a period of two (2) years from the date of substantial completion and acceptance of work by UMB. Any defects in workmanship, materials, or performance which appear within the guarantee period shall be corrected by the contractor without cost to the owner, within a reasonable time, to be specified by UMB. In default thereof, owner

may have such work done and charge the cost of same to the contractor. In addition to the above statement the Warranty/Guarantee Period shall include also all labor cost related to all warranty work. For compressorized equipment include an additional three (3) year Warranty/Guarantee Period.

PART 2 - PRODUCTS

2.1 LISTED MANUFACTURERS:

A. Listed Manufacturers: The listed manufacturers indicated in Part 2 of each specification section as the basis of design represents the minimum level of quality for materials and equipment that is acceptable to UMB. Unless otherwise indicated in each specification section, contractors may submit material and equipment by non listed manufacturers provided said submittals meet all of the requirements of these specifications. All submitted materials and equipment are subject to approval by the A/E and UMB.

B. Approved Equal Equipment Layouts: The equipment layouts and the related mechanical and electrical service connections, access space and supports indicated on the construction documents represent equipment provided by the specified basis of design manufacturer and model number. When the successful bidder chooses to provide "or approved equal" equipment by one (1) of the other listed manufacturers in the specifications, the bidder shall be responsible for providing all adjustments and modifications to the services necessary to make connections to the equipment, the bidder shall be responsible for installing the equipment such that all required clear access space is maintained, and the bidder shall be responsible for providing all adjustments and modifications to the equipment mounting and supports. All adjustments and modifications shall be provided by the bidder and appropriate subcontractors at no additional cost to the project.

PART 3 - EXECUTION

3.1 EQUIPMENT ROUGH IN AND FINAL CONNECTIONS

A. Locations: Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Rough in Requirements: Refer to equipment specifications included in the architectural, mechanical, and electrical specifications for equipment rough in requirements. Provide final connections for each piece of equipment.

C. Owner Furnished Equipment: Refer to owner supplies equipment specifications and/or cut sheets for equipment rough in requirements. Provide final connections for each piece of owner supplied equipment.

3.2 MECHANICAL INSTALLATIONS - PLUMBING

A. Verify all dimensions by field measurements.

B. Where plumbing systems, materials and equipment are intended for overhead installation, and where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible. Notify UMB - PM prior to installation of plumbing system components when headroom is less than 7'-6" and/or where existing system components will be below the new finished ceiling height. Notification shall be through the “RFI” process.

C. Install plumbing systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, identify the conflict and submit and “RFI” for each conflict to the Architect.

D. Install plumbing systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.

E. REFER TO DRAWING COORDINATION CHECKLIST.Install plumbing equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

F. Install access panel or doors where material and/or equipment requiring service will be concealed behind finished surfaces. Access panels and doors are specified in the architectural specifications.

G. Install plumbing systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

H. The contractor shall confirm that all pressure vessels are installed in full compliance with the requirements of the Sate Inspector’s Office for Boilers and Pressure Vessels. Refer to “Closeout Procedures” in this Section for additional requirements.

3.3 EXISTING PLUMBING SYSTEMS

A. Building: In no case shall the buildings plumbing systems be placed out of service for any period of time unless it is in an emergency condition as directed by the University.

Project Area: The parts of the plumbing systems serving the project area can be placed out of service for the construction period. When the construction is completed the plumbing system serving the project area shall be placed back in service.REFER TO DIVISION 1 SECTION "CUTTING AND PATCHING," TEXT AND EVALUATIONS, FOR GENERAL REQUIREMENTS BEFORE EDITING THIS ARTICLE. SPECIFY ONLY MECHANICAL-RELATED REQUIREMENTS HERE.

3.4 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 01 Specification Section "Cutting and Patching" In addition to the requirements specified in Specification Division 01, the following requirements apply:

1. Patch Materials: Patch finished surfaces and building components using new materials specified for the original installation and using experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

B. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, heating units, ductwork, plumbing fixtures and trim, and other mechanical items made obsolete by the new work.

3.5 PAINTING

A. Refer to Architectural Specification Section "Painting" for field painting requirements.

B. CONCRETE BASES

COORDINATE CONCRETE WORK WITH DIVISION 3.

Construct concrete equipment bases of dimensions indicated, but not less than four (4) inches (100 mm) larger than supported unit in both directions. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3,000 psi (20.70MPa), twenty eight (28) day compressive strength concrete and reinforcement bars as specified in the architectural specifications.

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS D1.1 "Structural Welding Code--Steel."

3.7 DEMOLITION

INCLUDE THIS ARTICLE IN RENOVATION PROJECTS. DELETE PARAS NOT REQUIRED FOR PROJECT.

A. Disconnect, demolish, and remove work specified as part of the plumbing specifications and as indicated. Remove pipes back to the active pipe to remain and cap.

B. Where pipe, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.

C. Accessible Work: Remove indicated exposed pipe and ductwork in its entirety.

D. Abandoned Work: Cut and remove buried pipe abandoned in place, two (2) inches (50 mm) beyond the face of adjacent construction. Cap and patch surface to match existing finish.

E. Removal: Remove indicated equipment from the Project site.

C. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

3.8 PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls and interior waterproof construction.

B. Furnish and install drains, curbs, vent assemblies, sleeves, flashing, etc. specifically designed for application to the particular construction. Install system in accordance with the roofing manufacturer's instructions.

3.9 EXCAVATION AND BACKFILLING

A. General: Perform all necessary excavation and backfilling necessary for the installation of underground plumbing services as part of Division 22 in accordance with the architectural specifications.

3.10 GROUTING

A. Install nonmetallic nonshrink grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's printed instructions.

B. Clean surfaces that will come into contact with grout.

C. Provide forms for placement of grout, as required.

D. Avoid air entrapment when placing grout.

E. Place grout to completely fill equipment bases.

F. Place grout on concrete bases to provide a smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout according to manufacturer's printed instructions.

3.11 CLEANING AND FINISHES

A. Clean surfaces prior to application of insulation, adhesives, coating, and paint.

B. Provide factory applied finish where specified.

C. Protect all finishes, and restore all finishes to their original condition if damaged as a result of work installed as part of the mechanical specifications.

D. Remove all construction marking and writing from exposed equipment, piping and building surfaces.

3.12 LINTELS

A. Lintels shall be provided for openings in masonry, brick, concrete, etc. walls to accommodate work of this division.

1. Lintels shall be provided under this division when not being provided under other divisions. Lintels shall be approved by the Architect.

3.13 ELECTRICAL REQUIREMENTS

A. Unless otherwise indicated, furnish and install control and interlock wiring for the equipment furnished under this division. In general, power wiring and motor starting equipment will be provided as specified in the electrical specifications.

1. Where the electrical requirements of the equipment furnished differ from the provisions made in the electrical specifications, make the necessary allowances as part of the mechanical specifications.
2. Where no electrical provisions are included in the electrical specifications, include all necessary electrical work as part of the mechanical specifications.

B. All electrical work performed as part of the mechanical specifications shall be provided in accordance with the electrical specifications.

3.14 PROVISIONS FOR ACCESS

A. Furnish and install adequate access to all plumbing components. The following list shall be used as a guide only:

1. Equipment
2. Valves
3. Cleanouts
4. Traps

5. Low point drains

B. Access shall be adequate as determined by the Architect.

C. Refer to contract drawings where access panels have been specifically located.

D. Where access is by means of lift out ceiling tiles or panels mark each access panel using small color coded or numbered tabs. Provide an index chart for identification. Place markers in corner of tile.

3.15 PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls and interior waterproof construction.

B. Furnish and install drains, curbs, vent assemblies, sleeves, flashing, etc. specifically designed for application to the particular construction. Install system in accordance with the roofing manufacturer's instructions.

3.16 OPERATION OF EQUIPMENT

A. Clean all systems and equipment prior to initial operation for testing and balancing.

B. Do not operate equipment unless all proper safety devices or controls are operational.

C. Provide all maintenance and service for equipment which is operated during construction.

D. Where specified and otherwise required, provide the services of a manufacturer's factory trained service organization to start the equipment.

3.17 TEMPORARY SERVICE AND EQUIPMENT USE

A. Temporary Service: Unless temporary services are required as part of the project, do not use plumbing systems for temporary services during construction unless authorized in writing by the Architect and/or UMB.

B. Equipment Use: Where such authorization is granted, temporary use of new and or existing equipment shall not limit or otherwise affect warranties or guarantees covering new equipment. Where equipment is used by the contractor the contractor shall perform all required preventive maintenance on the equipment during the construction period. Upon completion of work, clean and restore all new and/or existing equipment to new condition and replace all filters as necessary.

3.18 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of equipment and systems to Owner's personnel a minimum two (2) weeks prior to date of final inspection.

1. For equipment requiring seasonal operation, perform instructions for other seasons at the same time.
2. Training period shall be performed within one (1), two (2) week period.

B. Use operation and maintenance manuals and video as basis of instruction. Review contents of manual and video with personnel in detail to explain all aspects of operation and maintenance.

C. Demonstrate the following:

1. Start up.
2. Operation.
3. Control.
4. Adjustment.
5. Trouble shooting.
6. Servicing.
7. Maintenance.
8. Shutdown.

D. Provide at least forty (40) hours straight time instruction to the operating personnel.

1. This instruction period shall consist of not less than five (5) eight (8) hour days.
2. Time of instruction shall be designated by the Owner.
3. This instruction shall be in addition to instructional requirements of specific equipment specified elsewhere in the mechanical specifications.

3.19 LUBRICATION

A. All bearings, motors and all equipment requiring lubrication shall be provided with accessible fittings.

B. Before turning over the equipment to the Owner, the Installer shall provide the following:

1. Fully lubricate each item of equipment.
2. Provide one (1) year's supply of lubricant for each type of lubricant.
3. Provide complete written lubricating instructions, together with diagram locating the points requiring lubrication.

C. Motors and equipment shall be provided with grease lubricated roller or ball bearings with Alemite or equal extended grease fittings and drain plugs.

3.20 WALL AND FLOOR PENETRATION

A. All penetrations of partitions, walls and floors by ducts, piping or conduit under Specification Division 22 shall be sealed and caulked. Provide U.L. listed fire stopping systems at penetrations through fire walls as specified in the architectural specifications.

3.21 EQUIPMENT PROVIDED UNDER ANOTHER DIVISION AND BY OTHERS

A. The Installer of products under Division 22 shall make all system connections required to equipment furnished and installed under another division and by others.

B. It shall be the responsibility of the Installer to obtain all necessary data from the equipment supplied under other Divisions.

3.22 CONSTRUCTION RECORD DRAWINGS

A. As the work progresses, the contractor shall record on one (1) set of prints, the installed locations, sizes, and depths of pipes, services, equipment, etc. which may differ from the approved contract drawings.

B. Upon completion of the plumbing system installations, the plumbing contractor shall deliver to the construction manager one (1) complete set of the plumbing system marked-up blueprints of the plumbing contract drawings.

1. The mark-ups shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design.

C. At a minimum include the following installed conditions:

1. Location of all shut off valves, drain valves, and balancing valves with assigned valve tag numbers.
2. Show the location of concealed material and/or equipment requiring service such as strainers, point of use hot water heaters.
3. Actual entering/leaving invert elevations for domestic water, sanitary, storm water, services for the building.
4. Where building services are located below floor slabs show the actual low point invert elevation and the high point invert elevation for gravity piping systems.

3.23 CLOSEOUT PROCEDURES

A. Operating and Maintenance Instructions: Submit Complete Package At Least Two (2) Months Prior To Substantial Completion. Arrange for each installer of equipment that requires regular maintenance to meet with the Owner's personnel to provide instruction in proper operation and maintenance. If installers are not experienced in procedures, provide instruction by manufacturer's representatives. Include a detailed review of the following items:
1. Maintenance manuals, including a customized list of preventive maintenance items and annual schedule for maintenance.

2. Record documents.
3. Complete inventory of spare parts and materials.
4. Tools.
5. Lubricants.
6. Fuels.
7. Identification systems.
8. Control sequences.
9. Hazards.
10. Cleaning.
11. Warranties and bonds.
12. Maintenance agreements and similar continuing commitments.

B. As part of instruction for operating equipment, demonstrate the following procedures:

1. Start up.
2. Shut down.
3. Emergency operations.
4. Noise and vibration adjustments.
5. Safety procedures.
6. Economy and efficiency adjustments.
7. Effective energy utilization.

C. Pressure Vessel Inspections by the State of Maryland: For the purpose of obtaining and having UMB buildings insured by any commercial insurance carrier, the contractor shall arrange for the inspection of all pressure vessels installed during construction. The contractor shall contact the Office of Boiler and Pressure Vessel Inspections of the Department of Labor, Licensing and Regulations (DLLR), State of Maryland, and arrange for the inspections. The DLLR shall be notified at least thirty (30) days prior to installation. After such inspections are carried out by the State Inspector's office, Certificates of Compliance will be issued to the contractor of record to be turned over to the Owner's representative for compliance with current insurance regulations as part of the Project Documents. Examples of pressure vessels include boilers, heat exchangers, converters, expansion tanks, water heaters, hot water generators and storage tanks. Chillers are excluded and are covered under ASHRAE Guidelines.

3.24 FINAL CLEANING

A. General: General cleaning during construction is required by the General Conditions as indicated in Division 01 Specification Section "Temporary Facilities."

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.

C. Remove all mechanical clipping, wiring, nuts, bolts, etc. left on top of ceilings and ceiling tiles.

3.25 PROJECT PUNCH OUT

A. Architect/Engineer will perform punch out reviews and will provide the Contractor with a list of punch list items to be completed before contract close out. Each and every punch list item shall be initialed and dated by the Contractor when the work is complete. The Architect/ Engineer will not perform any punch list verification until all items have been completed, initialed, dated and the list returned to the Architect/Engineer. If any items have been initialed as being completed by the Contractor and the Architect/Engineer determines that the work is not complete, the Architect/Engineer shall be reimbursed by the Contractor at his regular hourly rate for any and all items requiring revisiting of the site by the Architect/Engineer. Reimbursement shall be made by deducting the Architect/Engineer fee from the Contractor's final payment.

END OF SECTION 220000

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SECTION 220517 – SLEEVES, SLEEVE SEALS, AND ECUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 22.

1.2 SUMMARY

A. This section includes the requirements for pipe sleeves, sleeve seals and escutcheons for piping systems using the following:

1. Pipe sleeves.
2. Sleeve-seal systems.
3. Grout.
4. Escutcheons.
5. Floor Plates.

1.3 ACTION SUBMITTALS

A. Product Data: For each product specified, include manufacturers cut sheets, dimensional data, performance data, installation instructions, specified options, and warranty information.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of the approved submittal for each product and material along with any applicable maintenance data in the project operation and maintenance manual.

1.5 WARRANTY/GUARENTEE

A. See Division 22, Specification Section “Basic Mechanical Requirements – Plumbing” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Pipe sleeves, sleeve seals and escutcheons shall be designed and selected, for the intended use, in accordance with the details on the drawings and the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Sleeve Seal Systems:
   a. Advance Products & Systems, Inc.
   b. CALPICO, Inc.
   c. Metraflex Company (The).
   d. Pipeline Seal and Insulator, Inc.
   e. Proco Products, Inc.

2.2 PIPE SLEEVES

A. Steel Pipe Sleeves: Steel pipe sleeves shall be standard black steel pipe Type E, Grade B, with plain ends conforming to ASTM A53/A53M.

B. Cast Iron Pipe Sleeves: Cast iron pipe sleeves shall be standard weight cast iron pipe with plain ends conforming to ASTM A74 and CISPI – 301.

2.3 SLEEVE SEAL SYSTEMS

A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.4 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5,000-psi, twenty eight (28) day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 ESCUTCHEONS

A. One (1) Piece, Cast-Brass Type, Deep-Pattern Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.

B. One (1) Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

C. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.

D. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.6 FLOOR PLATES

A. One (1) Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 GENERAL

A. Install all Plumbing System sleeves, escutcheons, and associated components as required in accordance with the applicable codes and the best practices of the industry.

B. The work under this section shall be coordinated with that of all trades so that all work may be installed in the most direct and workmanlike manner and so that interference between piping, ducts, equipment, architectural and structural features will be avoided.

C. Coordinate clearance requirements with CM/GC for piping penetrating walls and floor slabs.

D. Mix grout with clean potable water; if grout is to be in contact with stainless-steel surfaces, use demineralized water.

E. Install accessories that do not corrode or soften in either a wet or dry state.

3.2 PIPE SLEEVE INSTALLATION

A. For Fire-Rated Assemblies (Floors, Walls, Ceilings):

1. Use standard weight steel pipe or service weight cast iron pipe for pipe sleeves. Where sleeves are installed in floors and load bearing walls, use only standard weight steel pipe for pipe sleeves.
2. Provide a minimum of one half (1/2) inch annular space clearance around the entire circumference of the pipe passing through the sleeve.
3. Center pipe passing through sleeve.
4. Do not continue insulation through sleeve.
5. The entire annular space must be sealed with fire stopping sealant.
6. Seal ends of pipe insulation and butt insulation ends up to fire stopping sealant in sleeve.

7. Sleeves in walls must be installed flush with both finished wall surfaces.
8. Sleeves in floors must be installed with top of sleeve one (1) inch above the finished floor surface. The bottom of the sleeve must be flush with the finished surface of the underside of the floor assembly.
9. In finished areas provide an escutcheon plate around the bare pipe or insulated pipe passing through the assemblies to conceal the sleeve and sealant. If a riser clamp is in place, omit the escutcheon.

B. For Non Fire-Rated Assemblies:

1. Floors:

   a. Use standard weight steel pipe or service weight cast iron pipe for pipe sleeves.
   b. Provide a minimum of one half (1/2) inch annular space clearance around the entire circumference of the pipe passing through the sleeve.
   c. Center pipe passing through sleeve.
   d. Do not continue insulation through sleeve.
   e. The entire annular space must be sealed with waterproof sealant.
   f. Seal ends of pipe insulation and butt insulation ends up to waterproof sealant in sleeve.
   g. Sleeves must be installed with top of sleeve one (1) inch above the finished floor surface. The bottom of the sleeve must be flush with the finished surface of the underside of the floor assembly.
   h. In finished areas provide an escutcheon plate around the bare pipe or insulated pipe passing through the assemblies to conceal the sleeve and sealant. If a riser clamp is in place, omit the escutcheon.

2. Walls:

   a. Use standard weight steel pipe or service weight cast iron pipe for pipe sleeves for masonry walls. Where sleeves are installed in load bearing walls, use only standard weight steel pipe for pipe sleeves in masonry walls.
   b. Use standard weight steel or service weight cast iron for pipe sleeve in frame walls.
   c. For non-insulated pipes, provide a minimum of one half (1/2) inch annular space clearance around the entire circumference of the pipe passing through the sleeve.
   d. For insulated pipes, provide a minimum of one half (1/2) inch annular space clearance around the entire circumference of the insulation.
   e. Center insulated pipe passing through sleeve.
   f. Continue insulation through sleeve.
   g. The entire annular space must be sealed with smoke and acoustic sealant.
   h. Sleeves in wall must be installed flush with both finished wall surfaces.

i. In finished areas provide an escutcheon plate around the bare pipe or insulated pipe passing through the assemblies to conceal the sleeve and sealant.

C. Sealant Requirements: Comply with requirements for sealants specified Architectural Specification Section "Joint Sealants".

D. Fire-Barrier Penetrations: Comply with requirements for firestopping specified in Architectural Specification Section "Penetration Firestopping".

3.3 SLEEVE SEAL SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 ECUTCHEONS INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

C. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One (1) piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

END OF SECTION 220517

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SECTION 220519 – THERMOMETERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of Division 22.

1.2 SUMMARY

A. Section includes the requirements for thermometers, and gauges using the following:

1. Vapor actuated thermometers.
2. Thermowells.
3. Dial-type pressure gauges.
4. Gauge attachments.
5. Test plugs.

1.3 ACTION SUBMITTALS

A. Product Data: For each product specified, include manufacturers cut sheets, dimensional data, performance data, installation instructions, wirings diagrams, power requirements, specified options, and warranty information.

1.4 INFORMATIONAL SUBMITTALS

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

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of the approved submittal for each product and material along with any applicable maintenance data in the project operation and maintenance manual.

1.6 WARRANTY/GUARENTEE

A. See Division 22, Specification Section “Basic Mechanical Requirements – Plumbing” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Thermometers and gauges shall be designed and selected, for the intended use, in accordance with the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide HVAC pumps by one (1) of the following:

1. Pressure Gauges:
   a. Trerice, H.O. Company.
   b. Weiss Instruments, Inc.
   c. Weksler Instrument Corp.

2. Test Plugs:
   a. Trerice, H.O. Company.
   b. Flow Design Inc.
   c. Peterson Equipment Company Inc.

2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Brass or stainless-steel thermometer well.
3. Pressure Rating: Not less than piping system design pressure.
4. Stem length: To extend two (2) inches into fluid or center of pipe, whichever, is shorter.
5. Extension for Insulated Piping: Two (2) inches nominal, but not less than thickness of insulation.
6. Threaded Cap Nut: With chain permanently fastened to well and cap.

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

2.3 PRESSURE GAUGES

A. General Requirements:

1. Provide pressure gauges were indicated on the drawings and as specified.
2. Service and Scale Range in pounds per square inch (PSI):

   a. Domestic Cold Water: Zero (0) to two (2) times operating pressure.

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

1. Standard: ASME B40.100.

2. Case: Liquid-filled type; cast aluminum or drawn steel; four and one half (4-1/2) inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Match pressure connection size in first subparagraph below with gage attachment size.
5. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus one (1) percent of scale range.

C. Gage Attachments: Provide gage attachments as indicated below:

1. Syphons: one quarter (1/4) inch straight coil of brass tubing with threads on each end.
2. Gage Valves: Provide gage valves (specialty valves) as specified in Division 22 Specification Section “Valves for Plumbing Piping Systems”.

2.4 TEST PLUGS

A. Description: Nickel plated brass body test plug in one half (1/2) inch fitting.

B. Body: Length as required to extend beyond insulation.

C. Pressure Rating: 500 psig minimum.

D. Core Inserts: Two (2) self-sealing valve types, suitable for inserting a one eighth (1/8) inch (3mm) outside-diameter probe from a dial thermometer or pressure gage.

E. Core Material: According to the following for fluid and temperature range:

1. Air, Water, Glycol Oil, and Gas: 20ºF to 200ºF, neoprene rubber.
2. Air and Water: -30°F to 275°F (-35°C to 136°C), ethylene-propylene-diene-terpolymer (EDPM) rubber.

F. Test Plug Cap: Gasketed and threaded cap, with retention chain.

G. Test Kit: Provide test kit consisting of one (1) pressure gage and gage adapter with probe, two (2) bimetal dial thermometers and a carrying case

H. Pressure Gage and Thermometer Ranges: Approximately two (2) times systems operating conditions.

I. Body: Length as required to extend beyond insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of thermometers and gages in the piping systems. So far as practical, install thermometers and gages as indicated.

3.2 THREMOWELLS

A. Install thermowells with socket extending a minimum of two (2) inches into fluid or center of pipe, whichever is shorter.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

3.3 PRESSURE GAGES

A. Install pressure gauges in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.

B. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.

C. Install remote-mounted pressure gauges on panel.

D. For gauge valves see Division 22 Specification Section “Valves for Plumbing Piping Systems”.

E. Install test plugs in piping tees.

3.4 CONNECTIONS

A. Install thermometers and gauges adjacent to machines and equipment to allow service and maintenance of thermometers, gauges, machines, and equipment.

3.5 ADJUSTING

A. Adjust faces of thermometers and gauges to proper angle for best visibility.

B. Calibrate meters according to manufacturer's written instructions, after installation.

C. Adjusting: Adjust faces of meters and gages to proper angle for best visibility.

D. Cleaning: Clean windows of meters and gages and factory finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION 220519

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SECTION 220523 – VALVES FOR PLUMBING PIPING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23. a

1.2 SUMMARY

A. This section includes the requirements for shutoff, drain, specialty, and check valves installed in plumbing piping systems as follows:

1. Plumbing System ball valves.
2. Plumbing System check valves.
3. Plumbing System special valves.
4. Special Valves.

1.3 ACTION SUBMITTALS

A. Product Data: For each product specified, include manufacturers cut sheets, dimensional data, performance data, installation instructions, accessories, specified options, and warranty information. Identify valves for each plumbing system application.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of the approved submittal for each product and material along with any applicable maintenance data in the project operation and maintenance manual.

B. Additional Data: In addition to the approved submittals, for each valve type, include the manufacturers printed exploded view type parts and material list indicating how to dismantle, repair and reassemble the valve, and identifying each part.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: The installer shall be a qualified licensed installer within the jurisdiction and familiar with the installation of the valves specified herein for each piping system.

B. Compliance: Comply with the following:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.
4. NSF Compliance: NSF 61 for valve materials for potable-water service.

C. ProPress Valve Compliance: Valves in propress piping systems shall be in compliance with ASME B31.9 for building service piping valves.

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

1.6 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Information in this article is paraphrased from MSS.

B. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set ball and plug valves open to minimize exposure of functional surfaces.
4. Set butterfly valves closed or slightly open.
5. Block check valves in either closed or open position.

C. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

D. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

1.8 WARRANTY/GUARANTEE

A. See Division 22 Specification Section “Basic Mechanical Requirements – Plumbing” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Valves shall be designed and selected, for the intended use, in accordance with the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide lead free plumbing valves by one (1) of the following:

1. Ball Valves – Copper and Steel Piping Systems:
   a. Apollo.
   b. Milwaukee.
   c. Watts.
   d. Nibco.
   e. Viega.

2. Check Valves – Copper and Steel Piping Systems:
   a. Apollo.
   b. Milwaukee.
   c. Watts.

3. Special Valves:
   a. Watts.
   b. Spence.
   c. Wilkens.

C. See shut off, drain, & specialty valve application below for required valves.

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

E. Valve Sizes: Same as upstream/downstream piping unless otherwise indicated.

F. Valve Actuator Types:

1. Handlever: For quarter-turn valves NPS 6 and smaller.

G. Valves in Insulated Piping: With two (2) inch stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

H. Valve-End Connections:

1. Threaded Ball Valves: With threads according to ASME B1.20.1.
2. Press End Ball Valves: Where pro press piping systems are used.

2.2 SHUT OFF, DRAIN, AND SPECIALITY VALVE APPLICATIONS

A. General Application: All Valves installed in Plumbing Piping Systems shall be as specified below. For this application, Plumbing Piping Systems and Specialty Valves are defined as follows:

1. Domestic (Potable) Water System: Includes Cold Water, Hot Water, Piping utilizing solder joint and/or pro press joint method.
2. Specialty Valves: Valves used at connections for P/T Plugs, DP Switches, & Pressure Gages.
3. Special Valves: Used as solenoid valves and pressure reducing valves.

B. Shut Off, Drain and Specialty Valves – UMB Campus: Gate Vales will not be permitted for installation in these systems. Only listed manufacturers and model numbers below are acceptable to UMB.

1. Shut Off Valves for Domestic Water Solder Joint Piping Systems One Half (1/2) Inch to Two (2) Inch: Use Two (2) Piece Full Port Lead Free Ball Valves and Trim as indicated below:

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1) Conbraco Industries, Inc. Apollo Valves: 77FLF-140 Series, Brass Body.
2) Milwaukee Valve Company: UPBA400S Series, Bronze Body.
3) Watts Water Technologies: LFB6080, Brass Body.
4) Nibco Inc.: T-685-66 LF, Bronze Body.

b. Description:

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) CWP Rating: 600 psig.
4) Body Design: Two (2) piece.
5) Body Material: Bronze or Brass.
6) Ends: Threaded.
7) Seats: Modified Teflon double seal seats and Teflon seals.
8) Stem: Type 316 Stainless steel.
9) Ball: Type 316 Stainless steel, vented.
10) Port: Full.

11) Handle: Lever Type.
12) Lead free valves.
13) For valves used as combination balancing/shut off duty on HWR systems, provide memory stops.

2. Shut Off Valves for Domestic Water ProPress Piping Systems One Half (1/2) Inch to One and One Quarter (1 1/4) Inch: Use Two (2) Piece Full Port Lead Free Ball Valves and Trim as indicated below:

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1) Viega: 2971.1ZL, Bronze Body
2) Conbraco Industries, Inc. Apolloxpress 77WLF-140, Bronze Body.
3) Milwaukee: UPBA480S, Brass Body.

b. Description:

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) CWP Rating: 600 psig.
4) Body Design: Two (2) piece.
5) Body Material: Bronze or Brass.
6) Ends: Press ends, smart connect feature.
7) Seats: EPDM
8) Stem: Type 316 Stainless steel.
9) Ball: Type 316 Stainless steel, vented.
10) Port: Full.
11) Handle: Lever Type.
12) Lead free valves.
13) For valves used as combination balancing/shut off duty on HWR systems, provide memory stops.

3. Shut Off Valves for Domestic Water ProPress Piping Systems One and One Half (1-1/2) Inch and Two (2) Inch: Use Two (2) Piece Full Port Lead Free Ball Valves and Trim as indicated below:

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1) Viega: 2970.3ZL, Bronze Body
2) Conbraco Industries, Inc. Apolloxpress: 77WLF-140, Bronze Body.
3) Milwaukee: UPBA480S, Brass Body.

b. Description:

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) CWP Rating: 600 psig.
4) Body Design: Two (2) piece.
5) Body Material: Bronze or Brass.
6) Ends: Press ends, smart connect feature.
7) Seats: EPDM
8) Stem: Stainless steel.
9) Ball: Type 316 Stainless steel, vented.
10) Port: Full.
11) Handle: Lever Type.
12) Lead free valves.
13) For valves used as combination balancing/shut off duty on HWR systems, provide memory stops.

4. Shut Off Valves for Domestic Water Solder Joint Piping Systems Two and One Half (2-1/2) Inch and Larger: Use 200 CWP, Cast Iron, Flanged Butterfly Valves with EPDM Seat and Stainless Steel or Coated Ductile Iron Disc:

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1) ABZ Valve and Controls; a division of ABZ Manufacturing, Inc. Series 929.
2) Bray Series 31 with Trim 119.
3) Milwaukee ML223E.

b. Description:

1) Standard: MSS SP-67, Type I.
2) CWP Rating: 200 psig.
3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
5) Seat: EPDM.
6) Stem: One (1) or two (2) piece stainless steel.
7) Disc: Stainless steel or lead free nylon 11 coating on a ductile iron disk.
8) Handle: Wheel Type, Chain Operator, or Gear Operator.

5. Drain Valves for Domestic Water Solder Joint Piping Systems One Half (1/2) Inch to Two (2) Inch: Use Three Quarter (3/4) inch, Two (2) Piece Full Port Lead Free Ball Valves and Trim as indicated below:

   a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

      1) Conbraco Industries, Inc. Apollo Valves: 77FLF-140, Brass Body.
      2) Milwaukee Valve Company: UPBA400S, Bronze Body.
      3) Watts: LFB6080, Brass Body
      4) Nibco Inc.: T-685-66-LF, Bronze Body.

   b. Description:

      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig.
      3) CWP Rating: 600 psig.
      4) Body Design: Two piece.
      5) Body Material: Bronze, or Brass.
      6) Ends: Threaded.
      7) Seats: Modified Teflon double seal seats and Teflon seals..
      8) Stem: Type 316 Stainless steel.
      9) Ball: Type 316 Stainless steel, vented.
      10) Port: Full.
      11) Handle: Lever Type.
      12) Lead free valves.
      13) Three Quarter (3/4) inch capped hose connection.

6. Drain Valves for Domestic Water ProPress Piping Systems One Half (1/2) Inch to Two (2) Inch: Use Three Quarter (3/4) Piece Full Port Lead Free Ball Valves and Trim as indicated below:

   a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

      1) Viega: 2971.3ZL, Bronze Body.
      2) Conbraco Industries, Inc. Apollo Valves: 77WLF-140, Bronze Body.
      3) Milwaukee: UPBA – 480S, Brass Body.

   b. Description:

      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig.
      3) CWP Rating: 600 psig.

4) Body Design: Two (2) piece.
5) Body Material: Bronze or Brass.
6) Ends: Press ends, smart connect feature.
7) Seats: Modified Teflon double seal seats and Teflon seals.
8) Stem: Type 316 Stainless steel.
9) Ball: Type 316 Stainless steel, vented.
10) Port: Full.
11) Handle: Lever Type.
12) Lead free valves.

7. Drain Valves for Domestic Water Solder Joint Piping Systems Two and One Half (2-1/2) Inch and Larger: Use Two and One Half (2-1/2) Inch, Two (2) Piece Full Port Lead Free Ball Valves with Stainless Steel Trim as indicated below:

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1) Conbraco Industries, Inc. Apollo Valves: 77FLF-140 Series, Brass Body.
2) Milwaukee Valve Company: UPBA400S Series, Bronze Body.
3) Watts Water Technologies: LFB6080, Brass Body.
4) Nibco Inc.: T-685-66 LF, Bronze Body.

b. Description:

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) CWP Rating: 600 psig.
4) Body Design: Two piece.
5) Body Material: Bronze or Brass.
6) Ends: Threaded.
7) Seats: Modified Teflon double seal seats and Teflon seals..
8) Stem: Type 316 Stainless steel.
9) Ball: Type 316 Stainless steel, vented.
10) Port: Full.
11) Handle: Lever Type.
12) Lead free valves.
13) Two and One Half (2-1/2) inch capped fire hose connection.

8. Specialty Valves for Domestic Water Solder Joint Piping Systems: Use One Quarter (1/4) Inch, Two (2) Piece Full Port Lead Free Ball Valves and Trim as indicated below:

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1) Conbraco Industries, Inc. Apollo Valves: 77FLF-140 Series, Brass Body.
2) Milwaukee Valve Company: UPBA400S Series, Bronze Body.
3) Watts Water Technologies: LFB6080, Brass Body.
Nibco Inc.: T-685-66 LF, Bronze Body.

b. Description:

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) CWP Rating: 600 psig.
4) Body Design: Two piece.
5) Body Material: Bronze or Brass.
6) Ends: Threaded.
7) Seats: Modified Teflon double seal seats and Teflon seals.
8) Stem: Type 316 Stainless steel.
9) Ball: Type 316 Stainless steel, vented.
10) Port: Full.
11) Handle: Lever Type.
12) Lead free valves.

9. Specialty Valves for Domestic Water ProPress Piping Systems: Use One Half (1/2) Inch, Two (2) Piece Full Port Lead Free Ball Valves and Trim as indicated below:

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1) Viega: 2971.3ZL, Bronze Body.
2) Conbraco Industries, Inc. Apollo Valves: 77WLF-140, Bronze Body.
3) Milwaukee: UPBA – 480S, Brass Body.

b. Description:

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) CWP Rating: 600 psig.
4) Body Design: Two piece.
5) Body Material: Bronze or Brass.
6) Ends: Press end, smart connect feature.
7) Seats: EPDM
8) Stem: Type 316 Stainless steel.
9) Ball: Type 316 Stainless steel, vented.

10) Port: Full.
11) Handle: Lever Type.
12) Lead free valves.

2.3 CHECK VALVES

A. General: All check valves used in Domestic Water Piping Systems shall be lead free construction.

B. Bronze Lift Check Valves – Metallic Disc: Use Class 125, Lift Check Valves with Bronze Disc as indicated below:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Apollo
b. Milwaukee Valve Company.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Design: Vertical flow.
d. Body Material: ASTM B 61 or ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.
g. Lead free valves.

C. Bronze Lift Check Valves – Nonmetallic Disc: Class 125, Lift Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Apollo
b. Milwaukee Valve Company.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Design: Vertical flow.
d. Body Material: ASTM B 61 or ASTM B 62, bronze.

e. Ends: Threaded.
f. Disc: NBR, PTFE, or TFE.
g. Lead free valves.

D. Bronze Swing Check Valves – Metallic Disk: Use Class 125, Bronze Swing Check Valves with Bronze Disc as indicated below:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Apollo.
b. Milwaukee Valve Company.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

E. Bronze Swing Check Valves – Nonmetallic Disk: Use Class 125, Bronze Swing Check Valves with Nonmetallic Disc as indicated below:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Apollo.
b. Milwaukee Valve Company.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: PTFE or TFE.
g. Lead free valves.

2.4 SPECIAL VALVES

A. Water Temperature Limiting Devices:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

    a. Powers; a division of Watts Water Technologies, Inc.
    b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
    c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1070.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.

PART 3 - EXECUTION

3.1 GENERAL

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Valves shall be placed in such manner as to be easily accessible for smooth and easy hand wheel operation and packing maintenance.

B. Install valves in piping where shown and where listed herein:

1. To balance flows in water piping systems.
2. To isolate all items of equipment.

3. To isolate motorized flow control valves.
4. To isolate branch lines and risers at mains.
5. To drain low points in piping systems.
6. To drain pipe risers.
7. To drain equipment.
8. To drain trapped sections in the piping system.

C. Where piping or equipment may be subsequently remove, provide valves with bodies having integral flanges or full lugs drilled and tapped to hold valve in place so that downstream piping or equipment can be disconnected and replaced with blank-off plate while valve is still in service.

D. Valves for equipment and controls shall be installed full size of pipe before reducing size to make equipment connection.

E. Where there is no interference, shut-off valves shall be installed with handwheel up on horizontal runs of pipe to prevent accumulation of foreign matter in working parts of valves. In no case shall the stem be installed below the pipe centerline.

F. On valves, strainers, etc., installed in copper piping, provide a union on the discharge side of each valve and threaded adapters where copper piping connects to valves, strainers, etc.

G. Drawings indicate the general arrangement of piping, fittings, and specialties.

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

I. Install valves in a position to allow full handle movement.

J. Install safety relief valves on hot water generators, boilers, pressure vessels, etc. and elsewhere as required by ASME Boiler and Pressure Vessel Code. Pipe discharge without valves as shown on drawings, or to nearest floor drain if not shown on drawings. Comply with ASME Boiler and Pressure Vessel Code Section VIII, Division 1 for installation requirements.

K. Install shut-off valves upstream and downstream of each pressure regulator.

L. Where threaded ball valves are installed in brazed copper piping systems braze each threaded adapter on to the piping. After each adapter has cooled to the touch install the threaded ball valve. Do not connect the threaded adapter to the valve and then braze the adapter and valve to the piping as this will result in damage to the valve seals. If any valve, in the brazed piping systems are damaged due to faulty installation the damaged valves shall be replaced by the contractor at no cost to the University.

M. Where butterfly valves are installed in copper piping systems provide companion flanges and dielectric gasket kits for each flange. When valves and/or fittings are installed in piping where electrolysis may occur provide dielectric unions at each connection.

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

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

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

Q. Where solder end three (3) piece ball valves without tube extensions are installed in brazed copper piping systems, each valve shall be disassembled prior to installation. After the end sections are brazed to the pipe and after they have been cooled to the touch each valve shall be reassembled. Failure to disassemble the valve before brazing will result in damage to the valve seals. If any valve, in the brazed piping systems are damaged due to faulty installation the damaged valves shall be replaced by the contractor at no cost to the University.

R. Where solder end three (3) piece ball valves with tube extensions are installed in brazed copper piping systems, each valve shall be disassembled prior to installation. After the tube extensions have been brazed to the pipe and after they have been cooled to the touch each valve shall be reassembled. The manufacturer recommends the valve assembly be installed with one tube extension being covered with wet rags and the joint brazed. After the brazed tube extension has cooled to the touch, cover the other tube extension with wet rags and braze the joint. Do not braze the second tube extension while the first tube extension is still hot as this will result in damage to the valve seals. If any valve, in the brazed piping systems are damaged due to faulty installation the damaged valves shall be replaced by the contractor at no cost to the University.

S. Install balancing valves with memory stops in locations where they can easily be adjusted.

T. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Lift Check Valves: With stem upright and plumb.

3.3 SPECIAL VALVE APPLICATIONS

A. Install solenoid valves where indicated on the drawings and where required as make up water valves for HVAC Systems. See Division 23 Specification Sections for Building Automation Systems for interface with the BAS.

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

3.4 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.5 THREADED CONNECTIONS

A. Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.

B. Align threads at point of assembly.

C. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.

D. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

3.6 FLANGED CONNECTIONS

A. Align flange surfaces parallel.

B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

C. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

3.7 PRESS END CONNECTIONS

A. Press connections shall be made according to the manufacturer's installation instructions.

B. Where thread end valves are installed in press end piping systems, provide threaded adaptors for each valve and follow manufacturer's installation instructions.

C. Where flanged valves are installed in press end piping systems, provide flange connections for each valve and follow manufacturer's installation instructions.

END OF SECTION 220523

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SECTION 220529 – HANGERS AND SUPPORTS FOR PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 22.

1.2 SUMMARY

A. This section includes the requirements for hangers and supports for plumbing piping equipment as follows:

1. Metal pipe angers and supports.
2. Trapeze pipe hangers.
3. Thermal hanger shield inserts.
4. Fastener systems.
5. Pipe positioning system.
6. Pipe supports and curbs at roof level.
7. Miscellaneous materials

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.4 ACTION SUBMITTALS

A. Product Data: For each product specified, include manufacturers cut sheets, dimensional data, performance data, installation instructions, specified options, and warranty information.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of the approved submittal for each product and material along with any applicable maintenance data in the project operation and maintenance manual.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.8 WARRANTY/GUARANTEE

A. See Division 22, Specification Section “Basic Mechanical Requirements – Plumbing” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Hangers and supports shall be designed and selected, for the intended use, in accordance with the details on the drawings and the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide comparable product by one (1) of the following:

1. Metal Pipe Hangers and Supports:
   a. B-Line.
   b. Fee and Mason.
   c. Anvil.
   d. Michigan Hanger.

2. Thermal-Hanger Shield Inserts (Pre-Insulated Pipe Supports):
   a. Pipe Shields, Inc. (Piping technology & Products, Inc.)
   b. Bergen Pre-Insulated Pipe Supports
   c. Rilco.

3. Thermal-Hanger Shield Inserts:
   a. Pipe Shields, Inc. (Piping technology & Products, Inc.)
   b. Bergen Pre-Insulated Pipe Supports

c. Rilco.

4. Fastener Systems (Concrete Anchors):
   a. Hilti,
   b. Powers Fasteners or
   c. Red Head

5. Metal Framing Support System:
   a. Unistrut,
   b. B-Line Strut Systems
   c. Anvil-Strut
   d. Kindorf
   e. Hilti

6. Pipe Guides and Anchors:
   a. Shaw Pipe Shields
   b. Bergen Pre-Insulated Pipe Supports
   c. Rilco

7. Pipe and Equipment Supports - Roof Level:
   a. Pate Company.
   b. Roof Products and Systems (RPS).
   c. Tybar Corporation.

2.2 PIPE HANGERS AND SUPPORTS

A. Horizontal non-insulated, waste, vent and storm water piping hangers:

1. Two (2) inch and smaller Figure No. kB3170.
2. Two and one-half (2-1/2) inch and larger: Figure No. B3100.
3. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
4. Nonmetallic Coatings: Plastic coating, jacket, or liner.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Horizontal Non-Insulated Copper Piping Hangers:

1. Two (2) inch and smaller: Figure NO. B3104 CT.
2. 2-1/2) inch and larger: Figure No. B3104 CT.

C. Insulated Horizontal Piping Hangers: Cold and Hot Water (Domestic):

1. Two (2) inch and smaller: Figure No. B3108 with metal shield, Figure No. B3151.
2. Two and one-half (2-1/2) inch and larger: Figure No. B3108 with metal shield, Figure No. B3151.

2.3 TRAPEZE PIPE HANGERS

A. Description: Direct mounting hangers:

1. Grinnell No. 46.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend two (2) inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.7 FABRICATED EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

B. Delegated Design: Calculate requirements for support of equipment weight and restraint of both lateral and vertical dynamic forces at 150% of operating conditions.

C. Details: Detail fabrication of each support assembly. Show dimensions and methods of assembly and attachment to building structure.

2.8 PIPE SEALS AND CURBS - ROOF LEVEL

A. General: Where piping systems and conduits for power and controls serve HVAC equipment located above the roof level where indicated on the drawings and as specified.

B. Pipe Seal Assembly: Model PPS, for a single pipe application, shall be a one piece spun aluminum base with full five (5) inch sloped roof surface flange, graduated step PVC boot and adjustable stainless steel clamp.

C. Pipe Supports: Pipe supports shall be one (1) of the following:

1. Equipment Support Without Pipe Rollers: Pate Style ES equipment supports constructed of 18 gauge galvanized steel, unitized construction with integral base, continuous welded corner seams, pressure treated two (2) x four (4) wood nailer and counterflashing with galvanized screws. The overall height for each support shall be eighteen (18) inches from the finished roof to the top of the counterflashing plus the height of the pipe supports and the pipe. Contractor shall provide galvanized Unistrut type channel tracts, with galvanized washers, nuts, bolts, and pipe clamps to secure the pipe to the tract and the track to the equipment support.
2. Equipment Support With Pipe Rollers: Pate Style PRS or MPRS equipment supports constructed of heavy gage galvanized steel, unitized construction with integral base, continuous welded corner seams, pressure treated (2) x four (4) wood nailer and counterflashing with galvanized screws. Roller assembly shall include galvanized steel channel tracks, galvanized steel fittings, washers, nuts, bolts, and painted cast iron rollers. The overall height for each support shall be eighteen (18) inches from the finished roof to the top of the counterflashing plus the height of the pipe rack. Contractor shall provide galvanized insulation shields to protect the pipe insulation at each support point.

D. Pipe Curbs: Pipe curbs for pipes up to six (6) inches with or without insulation shall be as follows:

1. Pipe Curb Assembly: Pate Style PCC series pipe curb assembly constructed of heavy gauge galvanized steel, unitized construction with integral base plate, one

and one half (1-1/2) inch insulation, pressure treated two (2) inch x two (2) inch wood nailer. The overall height for each curb shall be eighteen (18) inches from the finished roof level to the top of the pipe cover. Assembly shall be furnished with an acrylic clad thermoplastic cover, galvanized fastening screws and graduated step boots with stainless steel clamps fit around the pipe risers passing through the curb assembly and cover. Mechanical contractor shall coordinate with Pate to provide the appropriate cap and boot package for the installed pipe with pipe insulation in the submittal package.

2.9 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, twenty eight (28) day compressive strength.
3. Water: Potable
4. Packaging: Premixed and factory-packaged.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Vertical Piping Riser Clamps:

1. Copper Pipe: Figure No. B3373CT.
2. Steel Pipe: Figure No. B3136 and B3137.

E. Beam Clamps and Attachments:

1. For bolt-on locations to structure, Figure Nos. B3291, B3036, B3050.
2. Welded beam attachments, Figure No. B3083.

F. Concrete Inserts:

1. For concrete spot inserts at single locations for casting into structure, Figure No. B3014 for pre- determined rod size and Figure No. B2500 for universal use.
2. For continuous slot concrete insert at multi-locations for casting into structure, Figure No. B2505.

G. Brackets:

1. For equipment and piping adjacent to walls or steel columns, Figure Nos. B3066, B3063 and B3067 depending on weight to be supported.

H. Pipe Rests:

1. For pipes close to floor where no expansion provision is required, Figure No. B3088T base stand with B3093 adjustable pipe saddles support.

I. Hanger Rods:

1. Hanger rod, Figure No. B3205.
2. Continuous threaded rod, Figure No. ATR.
3. Eye rods, Figure No. B3210 or B3211, depending on load supported.

J. Spring Hangers:

1. Light loads, movement less than 1-1/4 inches, Figure No. B3262 or B3264.

K. Protection Saddles:

1. Cast iron pipe, insulated, Figure No. B3108 with metal shield, Figure No. B3151.
2. For high temperature steel pipe, insulated, No. B3160, B3161, B3162, B3163, B3164, or B3165.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Install supports to allow for free expansion of piping. Support piping from building structural members using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. At no time shall hangers and supports overload building structural members. Fasten ceiling plates and wall brackets securely to structure and test to demonstrate adequacy of fastening.

B. Select and size building attachments properly in accordance with MSS Standards and manufacturer's published load rating information.

C. Coordinate hanger and support installation to properly group piping of all trades.

D. Suspend hangers by means of hanger rods. Perforated band iron and flat wire (strap iron) are not allowed.

E. Piping and ductwork shall be supported independently from other piping or ductwork.

F. Pipe hangers and supports shall not penetrate vapor barrier of pipe insulation.

G. Do not support equipment, piping or ductwork from metal roof decking or ceiling grid.

H. Install adequate supports so as not to over stress either piping or equipment to which piping is connected.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly supported piping from the building structure.

1. Horizontal Piping: Support horizontal piping within twelve (12) inches of each fitting and coupling.
2. Base of Vertical Piping: Provide MSS Type 52, spring hangers.
3. Vertical Pipe Supports: Install supports for vertical steel pipe and copper tubing at each floor level.
4. Individual, Straight, Horizontal Piping Runs:

a. One hundred (100) Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
b. Longer than One Hundred (100) Feet: MSS Type 43, adjustable, roller hangers.
c. Longer than One hundred (100) Feet if Indicated: MSS Type 49, spring cushion rolls.
d. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
e. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
f. Install stainless-steel pipe support clamps for vertical piping in corrosive environments

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
3. Multiple, Straight, Horizontal Piping Runs One hundred (100) Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

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

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than four (4) inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

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

H. Equipment support in first paragraph below requires calculating and detailing at each use.

I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

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

L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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

N. Upper attachments to structures shall have an allowable load not exceeding one quarter (1/4) of the failure (proof test) load but are not limited to the specific methods indicated.

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

P. Insulated Piping:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

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

a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): Twelve (12) inches long and 0.048 inch thick.
b. NPS 4 (DN 100): Twelve (12) inches long and 0.06 inch thick.
c. NPS 5 and NPS 6 (DN 125 and DN 150): Eighteen (18) inches long and 0.06 inch thick.
d. NPS 8 to NPS 14 (DN 200 to DN 350): Twenty four (24) inches long and 0.075 inch thick.
e. NPS 16 to NPS 24 (DN 400 to DN 600): Twenty four (24) inches long and 0.105 inch thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

Q. Conform to the table below for maximum spacing of supports and rod sizes:

1. Steel and Copper Pipe:

	Steel Pipe	Copper Tube	
Nom. Pipe Size - In.	Max. Span - Ft. (In)	Max. Span - Ft. (In)	Min. Rod Dia. – In.

Up to 3/4	7 (84)	5 (60)	3/8
1	7 (84)	6 (72)	3/8
1-1/4	7 (84)	7 (84)	3/8
1-1/2	9 (108)	8 (96)	3/8
2	10 (120)	8 (96)	3/8
2-1/2	11 (132)	9 (108)	1/2
3	12 (144)	10 (120)	1/2
3-1/2	13 (156)	11 (132)	1/2
4	14 (168)	12 (144)	5/8 (1/2 for copper)
5	16 (192)	13 (156)	5/8 (1/2 for copper)
6	17 (204)	14 (168)	3/4 (5/8 for copper)
8	19 (228)	16 (192)	7/8 (3/4 for copper)
10	22 (264)	18 (216)	7/8 (3/4 for copper)
12	23 (276)	19 (228)	7/8 (3/4 for copper)

a. Support vertical steel pipe and copper tube at each floor level.
b. Rod diameter may be reduced one (1) size for double-rod hangers, with three eights (3/8) inch minimum rods.

2. Sanitary and Storm Water Drain Piping Above Ground:

a. Support pipe and tubing in accordance with manufacturer's recommendations.
b. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1) NPS 1-1/2 and NPS 2: Sixty (60) inches with three eights (3/8) inch rod.
2) NPS 3: Sixty (60) inches with one half (1/2) inch rod.
3) NPS 4 and NPS 5: Sixty (60) inches with five eights (5/8) inch rod.
4) NPS 6 and NPS 8: Sixty (60) inches with three quarters (3/4) inch rod.
5) NPS 10 and NPS 12: Sixty (60) inches with seven eights (7/8) inch rod.
6) Spacing for ten (10) foot lengths may be increased to ten (10) feet. Spacing for fittings is limited to sixty (60) inches.
7) Install supports for vertical cast-iron soil piping every fifteen (15) feet.
8) Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to one and one half (1-1/2) inches.

3.6 PAINTING

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

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

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Architectural Specification Sections "Exterior Painting" and "Interior Painting."

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 220529

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SECTION 220553 – IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 22.

1.2 SUMMARY

A. This section includes the requirements for identification of piping and equipment in the building using the following:

Equipment labels.
1. Warning signs and labels.
2. Pipe system labels.
3. Stencils.
4. Valve tags and schedules.
5. Ceiling tags
6. Laminate signs
7. Warning tags.

B. All plumbing equipment, systems, piping, shall be identified

1.3 ACTION SUBMITTALS

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

1. Samples: For color, letter style, and graphic representation required for each identification material and device.
2. Data: Installation details, material descriptions, dimensions of individual components for each type tag and sign.
3. Equipment Label Schedule: Submit a sample equipment label schedule for each plumbing system. Include the equipment tag designation, name and location in an “xl” file format.
4. Valve Tag Schedule: Submit a sample valve tag schedule for each plumbing system. Include the valve tag designation, name and location in an “xl” file format.

1.4 CLOSEOUT SUBMITTALS

A. Operation & Maintenance Manual: Include a copy of the approved submittal for each product and material along with any applicable maintenance data in the project operation and maintenance manual.

B. Equipment Label Schedule: Include a complete equipment label schedule for each plumbing system. Include equipment tag designation, name and location, the operation and maintenance manual, in an "xl" electronic file format.

C. Valve Tag Schedules: Include a complete valve tag numbering schedule for each plumbing system. Include the system identification, valve number and location, in the operation and maintenance manual, in an "xl" electronic file format.

1.5 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

1.6 WARRANTY/GUARANTEE

A. See Division 22, Specification Section "Basic Mechanical Requirements – Plumbing" for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Labels, Signs and Tags: All labels, signs and tags shall conform to ANSI/OSHA requirements for letter/color combinations.

B. Basis of Design: The basis of design shall be mechanical identifications materials manufactured by the Seton Name Plate Corporation as follows:

1. Equipment Labels – Style M4562 – M4565
2. Warning Signs – Style M4562 – M4565
3. Plumbing Pipe Labels – Size 8SM - 32
4. Valve Tags – Style 374

C. Other Acceptable Manufacturers: Subject to compliance with requirements, provide mechanical identifications materials from one (1) of the following:

1. Brady (Wilt.) Co. Singmark Division.
2. Industrial Safety Supply Co., Inc.

2.2 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, one eighth (1/8) inch thick, and having predrilled holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than two and one half (2-1/2) inches by three quarter (3/4) inches.
3. Minimum Letter Size: One quarter (1/4) inch for name of units if viewing distance is less than twenty four (24) inches, one half (1/2) inch for viewing distances up to seventy two (72) inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two thirds (2/3) to three fourths (3/4) the size of principal lettering.
4. Fasteners: Self tapping stainless steel screws, except contact type permanent adhesive where screws cannot or should not penetrate the substrate.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's label as indicated on the construction documents.

C. Equipment Label Schedule:

2.3 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving one eighth (1/8) inch thick, and having predrilled holes for attachment hardware.

B. Minimum Label Size: Length and width vary for required label content, but not less than two and one half (2-1/2) inch by three quarter (3/4) inch.

C. Minimum Letter Size: One quarter (1/4) inch for name of units if viewing distance is less than twenty four (24) inches, one half (1/2) inch for viewing distances up to seventy two (72) inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two thirds (2/3) to three fourths (3/4) the size of principal lettering.

D. Fasteners: Self tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

E. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

F. Label Content: Include caution and warning information, plus emergency notification instructions.

2.4 PLUMBING PIPE SYSTEM LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

1. Do not use pipe labels or plastic tapes for bare pipes conveying fluids at temperatures of 125°F (52°C) or higher

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover or cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

1. Small Pipes: For external diameters less than six (6) inches (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

a. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
b. Adhesive lap joint in pipe marker overlap.
c. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than three quarter (3/4) inch wide; full circle at both ends of pipe marker, tape lapped one and one half (1-1/2) inches.

2. Large Pipes: For external diameters of six (6) inches and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than three (3) times letter height (and of required length), fastened by one of the following methods:

a. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than one and one half (1-1/2) inches wide; full circle at both ends of pipe marker, tape lapped three (3) inches.
b. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Pipe label contents shall comply with the following:

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least one and one half (1-1/2) inches high.
3. Label Designation and Colors: See chart on the next page.

PLUMBING SERVICE DESIGNATION	LABEL DISIGNATION	FIELD/LETTER COLOR
Sanitary Waste	Same as Service Designation	Green / White
Sanitary Vent	Same as Service Designation	Green / White
Domestic Cold Water	Same as Service Designation	Blue / White
Domestic Hot Water	Same as Service Designation	Blue / White
A/C Condensate Drain	Same as Service Designation	Green / White

2.5 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of three quarter (3/4) inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material Fiberboard or metal.
2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.6 VALVE TAGS AND SCHEDULE

A. General: Valve tags and schedule are required to identify what systems the valves are installed in, where the valves are located and what duty the valves perform. Valve duty usually includes the following:

1. Shut off duty for a room, equipment and/or a floor.
2. Combination balancing/shut off duty.
3. Riser isolation duty.
4. Drain valves.
5. Control valves.
6. Shut off duty for back flow preventer.

B. Valve Tags:

1. Description: Stamped or engraved with one quarter (1/4) inch letters for piping system abbreviation and one half (1/2) inch numbers with:

a. Brass Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
b. Fasteners: Brass wire-link chain

2. Plastic Laminate Valve Tags: Provide manufacturer's standard three thirty second (3/32) inch thick engraved plastic laminate valve tags, with piping system

abbreviation in one quarter (1/4) inch high letters and sequenced valve numbers one half (1/2) inch high, and with five thirty second (5/32) inch hole for fastener.

a. Provide One and one half (1-1/2) inch sq. black tags with white lettering, except as otherwise indicated.
b. Provide size, shape and color combination as specified or scheduled for each piping system.

3. Plastic Valve Tags: Provide manufacturer's standard solid plastic valve tags with printed enamel lettering, with piping system abbreviation in approximately three sixteenth (3/16) inch high letters and sequenced valve numbers approximately three eights (3/8) inches high, and with five thirty second (5/32) inch hole for fastener.

a. Provide one and one eighth (1-1/8) inch sq. white tags with black lettering.
b. Provide size, shape and color combination as specified or scheduled for each piping system.
c. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

4. Valve Tag Data: See chart on the next page:

PLUMBING VALVE SERVICE	VALVE TAG DISIGNATION
Domestic Cold Water Service	DCWS – #
Domestic Cold Water Service – BFP	DCWBFP – #
Domestic Cold Water	DCW – #
Domestic Hot Water	DHW – #

C. Valve Schedules: Provide a valve schedule in an “xl” file format for each Plumbing piping system. File shall include the valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room, space, equipment, pipe riser), and valve duty. Also mark valves for emergency shutoff and similar special uses as required by the project.

1. Numbering System: Valves shall be in numerical order starting with one (1) for each plumbing system.

2.7 CEILING MARKERS

A. Ceiling Grid and Access Panel Markers: Provide Kroy type clear adhesive printed labels with three sixteenth (3/16) inch high letters to identify the location and type of concealed components.

B. Ceiling Marker Data: For Plumbing printed data shall be as follows:

ITEM	SERVICE	LABEL
LP Drain	Low Point Drain	PL Valve – LPD – *
PRD Valve – DCW	Pressure Reducing Valve	PL Valve – PRDV – DCW
PRD Valve – DHW	Pressure Reducing Valve	PL Valve – PRDV – DHW
PRD Valve – LCW	Pressure Reducing Valve	PL Valve – PRDV – LCW
PRD Valve – LHW	Pressure Reducing Valve	PL Valve – PRDV – LHW
San Cleanout	Sanitary Drain Cleanout	PL – Cleanout – SAN

* System ID: Domestic Cold Water (DCW), Domestic Hot Water (DHW)

2.8 ENGRAVED PLASTIC LAMINATE SIGNS

A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: One eighth (1/8) inch, except as otherwise indicated.

C. Fasteners: Self tapping stainless steel screws, except contact type permanent adhesive where screws cannot or should not penetrate the substrate.

D. Nomenclature: Include the following, matching terminology on schedules as closely as possible.

E. Size: Provide approximate two and one half (2-1/2) inch x four (4) inch markers for control devices, dampers, and valves; and four and one half (4-1/2) inch x six (6) inches for equipment.

2.9 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Three (3) inches by five and one quarter (5-1/4) inches minimum.
2. Fasteners: Self tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

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

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Retain first paragraph below to identify piping systems by color-coded painting. Labels will still be required to identify service, pipe size, and flow direction.

B. Piping Color-Coding: Painting of piping is specified in Architectural Specification Section "Interior Painting."

C. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

D. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, and cable pull areas; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of fifty (50) feet along each run. Reduce intervals to twenty five (25) feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

E. Pipe Label Color Schedule:

3.4 VALVE TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units.

3.5 VALVE TAG SCHEDULE

A. Include the valve schedule file in the electronic operation and maintenance manual.

3.6 WARNING TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.7 CEILING MARKERS

A. Location: Install each ceiling marker label and a dot on the surface of the ceiling grid 'T' bar and/or on the frame of an access door.

3.8 ADJUSTING AND CLEANING

A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.

B. Cleaning: Clean face of identification devices.

END OF SECTION 220553

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SECTION 220700 – INSULATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 22.

1.2 SUMMARY

A. This section includes the requirements for insulating plumbing piping and equipment for the following:

1. Flexible elastomeric insulation.
2. Mineral fiber blanket insulation.
3. Mineral fiber preformed pipe insulation.
4. Insulating cement.
5. Achieves.
6. Mastics.
7. Lagging achieves.
8. Sealants.
9. Factory jackets.
10. Field cloths.
11. Field jackets.
12. Tapes.
13. Securements.
14. Protective shields.

1.3 ACTION SUBMITTALS

A. Product Data: For each specified product include:

1. Product Data: Product data for each type of mechanical insulation identifying manufacturer, k-value, thickness, and accessories. Include mastics, adhesives, jacketing, covers, canvas materials, vapor barrier material, etc.
2. Samples: Samples of each type of insulation and jacket. Identify each sample describing product and intended use. Submit the following sizes of sample materials:
   a. Board and Block Insulation: twelve (12) inches square section.
   b. Pre-Formed Pipe Insulation: twelve (12) inches long, two (2) inch NPS

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

1. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
2. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation & Maintenance Manual: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of twenty five (25) or less, and smoke-developed index of fifty (50) or less.
2. Insulation Installed Outdoors: Flame-spread index of seventy five (75) or less, and smoke-developed index of one hundred fifty (150) or less.

C. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.8 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Plumbing Specification Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.9 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

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

1.10 WARRANTY/GUARANTEE

A. See Division 22 Specification Section “Basic Mechanical Requirements – Plumbing” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Insulation and accessories shall be designed and selected, for the intended use, in accordance with the details on the drawings and the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Fiberglass, Fiber Board and Cellular Insulation: Subject to compliance with requirements, provide products by one (1) of the following:

a. Owings Corning Inc.
b. John Manville
c. Knauf Inc.

d. Pittsburgh Corning Corporation; Foamglas.

2. Elastromeric Insulation: Subject to compliance with requirements, provide products by one (1) of the following:

a. Armstrong.
b. Armcell
c. Knauf Inc.

3. Adhesives, Mastics, and Sealants: Provide adhesives, mastics and sealant products recommended by the insulation manufacturer or by one (1) of the following:

a. Foster Brand.
b. Fueller Company.
c. Eagle Bridge.

2.2 INSULATION MATERIALS

A. Comply with requirements in "Piping and Equipment Insulation Schedule.

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

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

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

2.3 FLEXIBLE ELASTOMERIC INSULATION

A. Closed-cell, with smooth skin on both sides. Comply with ASTM C 534, TYPE I for tubular materials.

2.4 MINERAL-FIBER, PREFORMED PIPE INSULATION

A. Type I, 850°F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.5 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

   a. Ramco Insulation, Inc.; Super-Stik.

2. Thermal Conductivity: 1.2 average maximum at 400ºF mean temperature.
3. Compressive Strength: 100 psi at 5% deformation.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

C. ADHESIVES Thermal Conductivity: 1.0 average maximum at 500ºF mean temperature.

1. Compressive Strength: 10 psi at 5% deformation.

2.6 ADHESIVES

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

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.7 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: -20°F to +180°F.
3. Solids Content: ASTM D 1644, 58% by volume and 70% by weight.
4. Color: Aluminum.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
2. Service Temperature Range: 0°F to 180°F.
3. Solids Content: ASTM D 1644, 44% by volume and 62% by weight.
4. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services..

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
2. Service Temperature Range: -50°F to +220°F.
3. Solids Content: ASTM D 1644, 33% by volume and 46% by weight.
4. Color: White.

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

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: -20°F to +180°F.
3. Solids Content: 60% by volume and 66% by weight.
4. Color: White.

2.8 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 0°F to 180°F.
4. Color: White.

2.9 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: -100°F to +300°F.
4. Color: White or gray.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and Vinyl, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: -40°F to +250°F.
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.10 FACTORY-APPLIED JACKETS

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

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2.11 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd.

2.12 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45 and 90 degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.13 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: Four (4) inch.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2%.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: Two (2) inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500%.
5. Tensile Strength: 18 lbf/inch in width.

2.14 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 0.015 inch thick, one half (1/2) inch wide
2. Aluminum: ASTM B 209 (ASTM B 209M with wing seal.), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, one half (1/2) inch wide with wing seal.

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

C. Wire: 0.080-inch nickel-copper alloy or 0.062-inch 1.6 soft-annealed, galvanized steel.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. C & F Wire.

2.15 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers,:

1. Description: Manufactured plastic wraps for covering plumbing hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that applies to insulation.

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

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

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

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with three (3) inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced four (4) inches on center.
3. Overlap jacket longitudinal seams at least one and one half (1-1/2) inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at two (2) inches on center.

a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least four (4) inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment.

1. Flexible connectors for pipes.
2. Vibration control devices.
3. Testing laboratory labels and stamps.
4. Nameplates and data plates.
5. Insulated access panels and doors in air distribution systems.
6. Fire protection piping systems.
7. Sanitary drainage and vent piping.
8. Drainage piping located in crawl spaces, unless indicated otherwise.
9. Chrome-plated pipes and fittings, except for plumbing fixtures for the disabled.
10. Piping specialties including air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least two (2) inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

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

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Architectural Specification Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Architectural Specification Section "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two (2) times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two (2) times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two (2) times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two (2) times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two (2) part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least two (2) inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover

assembly with insulating cement applied in two (2) coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

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

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least one (1) inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 FIELD-APPLIED JACKET INSTALLATION

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

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

B. Where PVC jackets are indicated, install with one (1)-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.9 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Architectural Specification Sections "Exterior Painting" and ”Interior Painting."

1. Flat Acrylic Finish: Two (2) finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two (2) coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations

of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.12 INDOOR PIPING INSULATION SCHEDULE

INSULATION SCHEDULE - PIPING SYSTEMS						
Pipe System	**Pipe Size in Inches (NPS)**	**Materials**	**Thickness in Inches**	**Vapor Barrier Required**	**Field Applied Jacket-MER**	**Field Applied Jacket NON-MER**
Sanitary Drains and Traps Exposed at Fixtures for Disabled	1/2 to 1 1/2	Flexible Elastomeric	1/2	Yes	None	None
Concealed Interior Domestic Water-40ºF - 110ºF	1/2 to 1, Branch Run outs	Fiberglass Flexible Elastomeric	1/2 1/2	Yes Yes	N /A N / A	None None
	1/2 to 1 1/2	Fiberglass	1	Yes	N / A	None
	2 to 36	Fiberglass	1 1/2	Yes	N / A	None

Exposed Interior Domestic Water Piping - 40ºF - 110ºF	1/2 to 1, Branch Run - outs	Fiberglass Flexible Elastomeric	1/2 1/2	Y Yes	Glass Cloth	PVC PVC
	1/ 2 to 1 1/2	Fiberglass	1	Yes	Glass Cloth	PVC
	2 to 36	Fiberglass	1 1/2	Yes	N / A	PVC

3.13 T INSULATION SCHDULE

END OF SECTION 220700

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SECTION 220800 – COMMISSIONING PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 22.

B. The OPR and BOD documentation are included by reference for information only.

1.2 SUMMARY

A. This section includes the requirements for commissioning the plumbing systems, assemblies and equipment.

1.3 DESCRIPTION

A. The following equipment and/or accessories shall be commissioned as part of this project:

1. Domestic hot water heating equipment
2. Safety equipment
3. Interface connections with the BAS.

1.4 ACTION SUBMITTALS

A. Refer to Division 01 Specification Section “COMMISSIONING” for CxA’s role.

B. Refer to Division 01 Specification Section “SUBMITTAL PROCEDURES” for specific requirements.

C. Refer to Division 01 Specification Section “COMMISSIONING” for additional submittal requirements related to submittals of equipment to be commissioned and Cx specific submittals.

1.5 COORDINATION

A. Refer to Division 01 Specification Section “COMMISSIONING” for requirements pertaining to coordination during the commissioning process.

1.6 GENERAL DOCUMENTATION

A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for all commissioned components, equipment, and systems.

1.7 WARRANTY/GUARENTEE

A. See Division 22, Specification Section “Basic Mechanical Requirements – Plumbing” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Refer to Division 01 Specification Section “COMMISSIONING” for requirements pertaining to testing equipment.

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify in writing to the CxA that plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Place systems, subsystems, and equipment into operating mode to be tested (e.g. for pumps, normal shutdown, normal auto position, normal manual position, emergency power, and alarm conditions).

C. Inspect and verify the position of each device and interlock identified on checklists.

D. Check safety cutouts, alarms, and interlocks during mode of operation.

E. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

C. The CxA along with the plumbing contractor shall prepare detailed testing plans, procedures, and checklists for applicable plumbing systems, subsystems, and equipment.

D. Tests will be performed using design conditions whenever possible.

3.3 PLUMBING SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Procedures: Where applicable follow manufacturer's written procedures. If no procedures are prescribed by the manufacturer, proceed as follows:

1. Plumbing Piping Distribution Systems: Includes domestic water piping.

    a. Verify that all valves and accessories have been installed correctly, are accessible and operate as intended.
    b. Verify that specified tests of piping are complete.

2. Plumbing Equipment: Includes backflow preventers, hot water heating equipment.

    a. Verify that all equipment has been installed in accordance with the manufactures recommendations and all equipment can be easily accessed for maintenance.
    b. Verify that all valves, trim, fittings, controls, and accessories have been installed correctly and operates as intended.
    c. Verify that all equipment test, training, and startup procedures have been completed per the specifications.
    d. Verify that all required interfaces with the BAS have been installed correctly and operates as intended.
    e. Operate equipment as intended to ensure the design conditions can be obtained.

END OF SECTION 220800

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SECTION 221100 – DOMESTIC WATER PIPING SYSTEMS & SPECIALITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 22.

1.2 SUMMARY

A. This section includes the requirements for domestic and/or laboratory water piping and specialties above ground within the building, and water service piping below the floor slab or underground to five (5) feet outside the building, and includes the following**:**

1. Copper tubing and fittings.
2. Ductile iron pipe and fittings.
3. Gaskets.
4. Transition fittings.
5. Dielectric fittings.
6. Vacuum breakers
7. Backflow preventers.
8. Outlet boxes.
9. Hose bibbs.
10. Wall hydrants.
11. Water-hammer arresters.
12. Air vents.
13. Trap-seal primer valves and systems.
14. Flexible connectors.
15. Water meters.

1.3 SUBMITTALS

A. Action Submittals:

1. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, and warranty information.

1.4 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation & Maintenance Manual: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

1.6 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: The installer shall be a qualified licensed installer within the jurisdiction and familiar with the installation of the pipe and fittings specified herein for each piping system.

B. Compliance: Potable-water piping and components shall comply with NSF 14 and NSF 61.

C. Source Limitations: Obtain pipe and fittings from the same manufacturer for each pipe system.

1.8 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Construction Manager no fewer than five (5) days in advance of proposed interruption of water service.
2. Do not interrupt water service without Construction Manager's written permission.

1.9 WARRANTY/GUARENTEE

A. See Division 22, Specification Section “Basic Mechanical Requirements – Plumbing” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Material Design and Selection: Domestic and Laboratory water pipe, fittings, and specialties shall be designed and selected, for the intended use, in accordance with the sizes on the drawings and the requirements of this specification.

B. Acceptable Manufacturers: Acceptable manufacturers shall be as follows:

1. Ductile Iron Piping Systems: All ductile iron pipe and fittings shall be by one (1) manufacturer.

   a. American Cast Iron Pipe Company.
   b. US Pipe Company.
   c. Atlantic States Cast Iron Pipe Company.

2. Copper Tube Piping Systems:

   a. Solder Joint Copper Tube and Fittings: All copper tube and/or fittings for solder joint application shall be by one (1) manufacturer.

      1) Mueller Industries

   b. Press Type Copper Piping Systems: The basis of design is Viega ProPress copper piping system. Other acceptable manufacturers are:

      1) Nibco Inc.
      2) Elkhart Products Corporation – Apollo XPress.

3. Dielectric Fittings:

   a. Unions: Watts, Zurn and Capitol Manufacturing Company.
   b. Flanges: Watts, Zurn and Capitol Manufacturing Company.
   c. Insulating Kits: Pipeline Seal and Insulator Company, Calpico, Inc.
   d. Nipples: Victaulic, Precision Plumbing Products, Inc. and Elster Perfection

4. Vacuum Breakers: Watts, or Zurn.

5. Backflow Preventers: Watts, or Zurn.

6. Outlet Boxes: Oatey, Acorn Engineering Company or LSP Products Group Inc.

7. Wall Hydrants and Hose Bibbs: Josam or Zurn.

8. Water Hammer Arresters: Jay R. Smith, AMTROL, Inc., or Ancon.

9. Trap Primer Devices: Sloan, E&S Primer Valve, Zurn or Josam.

10. Flexible Connectors: Metraflex Corporation or approved equal

2.2 DOMESTIC WATER PIPE MATERIAL APPLICATION

A. General Application: All pipe, fittings and joint methods shall be as specified below. For this application, Domestic Water Piping Systems are defined as follows:

1. Building Water Service Piping System: Cold Water piping from the meter vault to the building and up through the floor slab.
2. Domestic (Potable) Water Piping Systems: Includes Cold Water, Hot Water, Piping serving non-laboratory areas of the building or project area.

B. Domestic Water Pipe Material Application Schedule:

Pipe System	Pipe Material	Fitting Material	Joint Method
Building Water Service to 5 feet beyond building underground.	Copper Tube: ASTM B88, Type 'K', Seamless, Water Tube, hard drawn temper.	1 inch to 2-1/2 inch, Copper Tube: ASTME B16.22, wrought copper or copper alloy solder joint, 150 lb.	ASTM B32, alloy Sb5 (95 percent tin, and 5 percent antimony), with 0.2 percent maximum lead content. ASTM B813 water flushable flux.
Building Water Service to 5 feet beyond building underground.	Ductile Iron: AWWA C151/A21.15 or AWWA C104 cement motor lining.	Piping 3 inch and larger: Ductile Iron: AWWA C110 or AWWA C153/A21.53 with AWWA C104 cement motor lining.	Push on or mechanical joints and gaskets: AWWA C111/A21.11.
Domestic Cold, Hot, piping, Above Ground within the building	Copper Tube: ASTM B88, Type 'L', Seamless, Water Tube, hard drawn temper.	1/2 inch to 2 inch, Copper Tube: ASTME B16.22, wrought copper or copper alloy solder joint, 150 lb.	ASTM B32, alloy Sb5 (95 percent tin, and 5 percent antimony), with 0.2 percent maximum lead content. ASTM B813 water flushable flux.
		1/2 inch to 2 inch Viega ProPress copper fittings with EPDM seals. (Contractor Option)	Press connection with EPDM sealing element. (Contractor Option)

2.3 DUCTILE-IRON PIPE FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.4 COPPER TUBE MISCELLANEOUS FITTINGS

A. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

B. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

2.5 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

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

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.6 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Standard: ASSE 1079.
2. Pressure Rating: 125 psig minimum at 180°F.
3. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Standard: ASSE 1079.
2. Factory-fabricated, bolted, companion-flange assembly.
3. Pressure Rating: 125 psig minimum at 180°F.
4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Non-conducting materials for field assembly of companion flanges.
2. Pressure Rating: 150 psig.
3. Gasket: Neoprene or phenolic.
4. Bolt Sleeves: Phenolic or polyethylene.
5. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Standard: IAPMO PS 66.
2. Electroplated steel nipple complying with ASTM F 1545.
3. Pressure Rating and Temperature: 300 psig at 225°F.
4. End Connections: Male threaded or grooved.
5. Lining: Inert and noncorrosive, propylene.

2.8 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Standard: ASSE 1001.
2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
3. Body: Bronze.
4. Inlet and Outlet Connections: Threaded.
5. Finish: Rough bronze or Chrome plated.

B. Hose-Connection Vacuum Breakers:

1. Standard: ASSE 1011.
2. Body: Bronze, non-removable, with manual drain.
3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
4. Finish: Chrome or nickel plated or Rough bronze.

2.9 BACKFLOW PREVENTERS

A. Reduced-Pressure Backflow Preventers:

1. Standard: ASSE 1013.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 12 psig maximum, through middle third of flow range.
4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
6. Configuration: Designed for horizontal, straight-through flow.
7. Accessories:

    a. Valves: See Valve section
    b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Double-Check, Backflow-Prevention Assemblies:

1. Standard: ASSE 1015.
2. Operation: Continuous-pressure applications unless otherwise indicated.
3. Pressure Loss: 5 psig maximum, through middle third of flow range.
4. Body: Bronze.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
6. Configuration: Designed for horizontal, straight-through flow.

C. Hose Connection Backflow:

1. Standard: ASSE 1052.
2. Operation: Up to ten (10) foot head of water back pressure.
3. Inlet Size: NPS 1/2 or NPS 3/4.
4. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
5. Capacity: At least three (3) gpm flow.

2.10 OUTLET BOXES

A. Icemaker Outlet Boxes:

1. Mounting: Recessed.
2. Material and Finish: Enameled-steel, epoxy-painted-steel, or plastic box and faceplate.
3. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
4. Supply Shutoff Fitting: NPS 1/2 ball valve and NPS 1/2 copper, water tubing.

2.11 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish: Rough bronze.
9. Operation: Operating key.

2.12 WALL HYDRANTS

A. Non freeze Wall Hydrants:

1. Standard: ASME A112.21.3M for concealed outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig.
3. Operation: Loose key.
4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
5. Inlet: NPS 3/4.
6. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounted with cover.
8. Box and Cover Finish: Polished nickel bronze.

9. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.

2.13 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Metal bellows or Copper tube with piston.
3. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes 'A' through 'F'.

2.14 AIR VENTS

A. Bolted Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating and Temperature: 125-psig minimum pressure rating at 140°F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 inch minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded Construction Automatic Air Vents:

1. Body: Stainless steel.
2. Pressure Rating: 150 psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.15 TRAP PRIMER DEVICES AND SYSTEM

A. Trap Primer Device - Flush Valve Type:

1. Where applicable, priming lines may be connected to a Sloan F72-A1 trap primer

B. Trap Primer Device - Pressure Differential Valve Type:

1. Primers shall be E&S Primer Valves, Zurn, Josam or equal chrome plated with vandal-proof screws and with three eighth (3/8) inch water connections, as connected as to the prime the trap on a variation in water pressure in the mains. Take water connections from the nearest cold water line and provide the loose key stops. Set primers above floor level of the drains they serve. Primer valves behind walls shall be provided with access doors as specified hereinbefore.

C. Trap-Seal Primer Systems:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

   a. Precision Plumbing Products.
   b. Zurn Industries, LLC.
   c. Watts.

2. Standard: ASSE 1044.
3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
4. Cabinet: Surface-mounted steel box with stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.

   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.

6. Vacuum Breaker: ASSE 1001.
7. Number Outlets: Eight.
8. Size Outlets: NPS 1/2.

2.16 FLEXIBLE CONNECTORS

A. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

B. Working-Pressure Rating: Minimum 200 psig.

C. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.

D. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

E. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.
2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.17 BUILDING SERVICE DOMESTIC WATER ENERGY METER

A. Provide building service domestic water energy meter where indicated on the construction documents. See Division 23 Specification Sections for the “Building Automation Systems” for meter requirements.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Division 31 Specification Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install domestic water piping level with 0.25% slope downward toward drain without pitch and plumb.

E. Install domestic water piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

F. Install domestic water piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

G. Install domestic water piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

H. Install domestic water piping to permit valve servicing.

I. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

J. Install domestic water piping free of sags and bends.

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

L. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

M. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Division 22 Specification Section "Thermometers and Gauges for Plumbing Piping."

N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Specification Section "Sleeves, Sleeve Seals and Escutcheons for Plumbing Piping."

O. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Specification Section "Sleeves, Sleeve Seals and Escutcheons for Plumbing Piping."

P. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Specification Section "Sleeve, Sleeve Seals and Escutcheons for Plumbing Piping."

3.3 PIPE SPECIALTIES INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Where required install outlet boxes recessed in wall or surface mounted on wall. Install two (2) inch by four (4) inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Architectural Specification Section "Rough Carpentry."

C. Set non-freeze, non-draining-type post hydrants in concrete or pavement.

D. Install water-hammer arresters in water piping according to PDI-WH 201.

E. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

F. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1%, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

G. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1%, and connect to floor-drain body, trap, or inlet fitting.

H. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1%, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.4 JOINT CONSTRUCTION

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

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

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

H. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

I. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.5 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

3.6 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices in Division 22 Specification Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger, support products, and installation in Division 22 Specification Section "Hangers and Supports for Plumbing Piping and Equipment."

3.8 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.9 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Division 22 Specification Section "Identification for Plumbing Piping and Equipment."

3.10 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

    a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
    b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

        1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.

        2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

    c. Re-inspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for re-inspection.
    d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Prepare test and inspection reports.

3.11 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
    b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.12 CLEANING

A. Clean and disinfect domestic and laboratory water piping systems as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for twenty four (24) hours.

2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three (3) hours.
c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.13 MISCELLANIOUS FITTINGS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

3.14 LEAK TEST PIPING SYSTEMS

A. See Division 22 Specification Section “Leak Test Plumbing Piping Systems” for testing requirements.

END OF SECTION 221100

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SECTION 221113 – FACILITY WATER, SEWER AND STORM WATER SERVICE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.2

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 22.

1.3 SUMMARY

A. This Section includes the requirements for potable water service, sanitary and storm water piping and specialties below grade from five (5) feet outside the building to the points of connection to meter vaults and to the municipal utilities and includes the following**:**

B.

1. Cast iron pipe and fittings.
2. Ductile iron pipe and fittings.
3. Transition couplings.
4. Cleanouts.
5. Concrete.
6. Piping specialties.

1.4 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, specified options, and warranty information.

B.

C. Shop Drawings: Provide details for precast concrete manholes and meter vault assemblies and indicate dimensions, method of field assembly, and components.
1.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

B. Field quality control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.
   1.

1.7 COORDINATION

A. Coordinate the installation of the potable water, sanitary, and storm water service mains with the Baltimore City Department of Public Works (BCDPW) all other trades that have work close to and/or in the same area of the project site.

1.8 QUALITY ASSURANCE

A. Service Components and Accessories: All utility service components and accessories shall be installed using new materials designed and built in accordance with the best practices of the industry. Each major item or material shall bear the manufacturer's name and nominal size, if applicable.

B. Installing Contractor: The contractor installing the exterior water mains, including the meter vaults and meter assemblies, sanitary mains, storm water mains, related manholes and the connections to the city utilities shall be licensed and approved by The Baltimore City Department of Public Works (BCDPW) and has been a contractor in good standing with the BCDPW for at least ten (10) years.

C. Regulatory Requirements:
   1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
   2. Comply with standards of authorities having jurisdiction for potable water service piping, including materials, installation, testing, and disinfection.
   3. Comply with standards of authorities having jurisdiction for fire suppression water service piping, including materials, hose threads, installation, and testing.

D. Piping materials shall bear label, stamp, or other markings of specified testing agency.

E. NSF Compliance:
   1. Comply with NSF 61 for materials for water service piping and specialties for domestic water.
   2.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
   1. Ensure that valves are dry and internally protected against rust and corrosion.
   2. Protect valves against damage to threaded ends and flange faces.
   3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:
   1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
   2. Protect from weather. Store indoors and maintain temperature higher than ambient dew point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping with factory applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside a building.

F. Protect flanges, fittings, and specialties from moisture and dirt.

1.10 PROJECT CONDITIONS

A. Interruption of Existing Utility Services: Do not interrupt existing utility services (water, sanitary and/or storm water) to facilities occupied by UMB or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify UMB Office of Facilities Management no fewer than ten (10) working days in advance of proposed interruption of existing utility services.
   2. Do not proceed with interruption of existing utility services without written permission from the UMB Office of Facilities Management.

1.11 WARRANTY AND GUARENTEE

A. Comply with Section 220000 “Basic Mechanical Requirements – Plumbing” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

2.2

A. Material Design and Selection: Facility water, drainage and sewer pipe, fittings, and specialties shall be designed and selected, for the intended use, in accordance with the sizes on the drawings and the requirements of this specification.

B. Acceptable Manufacturers:
1. Ductile Iron Water Service Pipe: All ductile iron pipe and fittings shall be by one (1) of the following manufacturers:
a. American (American Cast Iron Pipe Company).
b. US Pipe Company.
c. Atlantic States Cast Iron Pipe Company.
2.
3. Cast Iron Sanitary and Storm Water Pipe - Hub and Spigot Cast Iron Piping System: All cast iron pipe and fittings shall be by one (1) of the following manufacturers:
a. Charlotte Pipe Company
b. Tyler Pipe Company

4. Cleanouts: All cleanouts exterior to the building shall be by one (1) of the following manufacturers:
a. Josam Company.
b. Smith, Jay R. Mfg. Co.
c. Tyler Pipe.
d. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

C. PIPE APPLICATION SCHEDULE

D.

E.

<table>
<tr><th>Pipe System</th><th>Pipe Material</th><th>Fitting Material</th><th>Joint Material</th></tr>
<tr><td rowspan="2">Sanitary and Storm Water Piping Mains Below Grade from five (5) feet beyond the building to connections to the city utilities</td><td>Cast Iron: Service Weight, Hub and Spigot Piping
4 inch – 15 inch, ASTM A74</td><td>Cast Iron: Service Weight, Hub and Spigot, ASTM A74</td><td rowspan="2">Hub and Spigot, Lead and Oakum joints or compression gaskets, ASTM C 564</td></tr>
<tr><td colspan="2">All Cast Iron Soil Pipe and Fittings shall be marked with the Collective Trade Mark of the Cast Iron Soil Pipe Institute (CISPI) and listed by NSF International.</td></tr>
</table>

2.3

2.4 NON PRESSURE TYPE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion resistant metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
   1. For Cast Iron Soil Pipes: ASTM C 564, rubber.

2.5 CLEANOUTS

A. Description: ASME A112.36.2M, round, gray iron housing with clamping device and round, secured, scoriated, gray iron cover. Include gray iron ferrule with inside calk or spigot connection and countersunk, tapered thread, brass closure plug.
   1. Top Loading Classification(s): Medium Duty and Heavy Duty.
   2. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast iron soil pipe and fittings.

2.6 JOINING MATERIALS

A. Refer to Section "Common Work Results for Utilities" for commonly used joining materials.

2.7 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Dielectric Fittings:
   1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
   2. Dielectric Unions:
   3.
      a. Description:
      b.
         1) Standard: ASSE 1079.
         2) Pressure Rating: 125 psig minimum at 180°F.
         3) End Connections: Solder joint copper alloy and threaded ferrous.
   4. Dielectric Flanges:
   5.
      a. Description:
         1) Standard: ASSE 1079.
         2) Factory fabricated, bolted, companion flange assembly.
         3) Pressure Rating: 125 psig minimum at 180°F.
         4) End Connections: Solder joint copper alloy and threaded ferrous; threaded solder joint copper alloy and threaded ferrous.
   6. Dielectric-Flange Insulating Kits:
   7.
      a. Description:
         1) Non conducting materials for field assembly of companion flanges.
         2) Pressure Rating: 150 psig.

3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.

8. Dielectric Nipples:
9.

a. Description:
1) Standard: IAPMO PS 66
2) Electroplated steel nipple complying with ASTM F 1545.
3) Pressure Rating: 300 psig at 225°F.
4) End Connections: Male threaded or grooved.
5) Lining: Inert and noncorrosive, propylene.

2.8 CORROSION PROTECTION PIPING ENCASEMENT

A. Encasement for Underground Metal Piping:
1. Standards: ASTM A 674 or AWWA C105.
2. Form: Sheet or tube.
3. Material: LLDPE film of 0.008 inch min mum thickness.
4. Material: LLDPE film of 0.008 inch minimum thickness, or high density, crosslaminated PE film of 0.004 inch minimum thickness.
5. Material: High density, crosslaminated PE film of 0.004 inch minimum thickness.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with excavating, trenching, and backfilling requirements in Division 31 Specification Section “Earth Moving”.

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer and storm drain piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe jacking process of micro tunneling.

F. Install gravity flow, nonpressure, sewer and drainage piping according to the following:
   1. Install piping pitched down in direction of flow, at minimum slope of 1% unless otherwise indicated.
   2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast in place concrete supports or anchors.
   3. Install piping with thirty six (36) inch minimum cover.
   4. Install hub and spigot, cast iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
   5. Install ductile iron, gravity sewer piping according to ASTM A 746.

G. Install force-main, pressure piping according to the following:
   1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast in place concrete supports or anchors.
   2. Install piping with thirty six (36) inch minimum cover.
   3. Install ductile iron pressure piping according to AWWA C600 or AWWA M41.
   4. Install ductile-iron special fittings according to AWWA C600.

H. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 CONCRETE PLACEMENT

A. Place cast in place concrete according to ACI 318.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
   1. Use Light Duty, top loading classification cleanouts in earth or unpaved foot traffic areas.
   2. Use Medium Duty, top loading classification cleanouts in paved foot-traffic areas.
   3. Use Heavy Duty, top loading classification cleanouts in vehicle traffic service areas.
   4. Use Extra Heavy Duty, top loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast in place concrete block, eighteen (18) inches by eighteen (18) inches by twelve (12) inches deep. Set with tops one (1) inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 JOINT CONSTRUCTION

A. See Section "Common Work Results for Utilities" for basic piping joint construction.

B. Make pipe joints according to the following:
   1. Ductile Iron Piping, Gasketed Joints for Water Service Piping: AWWA C600 and AWWA M41.
   2. Ductile Iron Piping, Gasketed Joints for Fire Service Main Piping: UL 194.
   3. Ductile Iron Piping, Grooved Joints: Cut groove pipe. Assemble joints with grooved end, ductile iron piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
   4. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
      a. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples.
      b. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
      c. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 CONNECTIONS

A. Connect water-distribution piping to interior domestic water and fire-suppression piping.

B. Ground equipment according to Division 26, Specification Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26, Specification Section "Low-Voltage Electrical Power Conductors and Cables."

3.7 CONNECTIONS FOR STORM AND SEWER PIPING

A. Connect nonpressure, gravity flow drainage piping to building's sanitary building drains specified in Division 22 Specification Section "Sanitary, Chemical and Vent Piping Systems."

B. Connect non pressure, gravity flow drainage piping in building’s storm building drainage specified in this section.

C. Make connections to existing piping and underground manholes.
   1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and

encase entire wye fitting plus six (6) inch overlap with not less than six (6) inches of concrete with twenty eight (28) day compressive strength of 3,000 psi.

2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than six (6) inches of concrete with twenty eight (28) day compressive strength of 3,000 psi.

D. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes by cutting opening into existing unit large enough to allow three (3) inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in six (6) inches of concrete for minimum length of twelve (12) inches to provide additional support of collar from connection to undisturbed ground.
   1. Use concrete that will attain a minimum twenty eight (28) day compressive strength of 3,000 psi unless otherwise indicated.
   2. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
   3. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

E. Connect to grease oil and sand interceptors specified in Division 22, Section "Sanitary Waste Interceptors."

3.8 FIELD QUALITY CONTROL

A. Piping Tests:

B. Prepare and submit test reports.

3.9 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Division 31 Specification Section "Earth Moving."

B. Permanently attach equipment nameplate or marker indicating plastic water service piping, on main electrical meter panel. See Division 33 Specification Section "Common Work Results for Utilities" for identifying devices.

3.10 CLEANING

A. Clean and disinfect water distribution piping as follows:

1. Purge new water distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
4.
    a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for twenty four (24) hours.
    b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for three (3) hours.
    c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
    d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

3.11 FIELD QUALITY CONTROL FOR STORM AND SEWER PIPING

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately twenty four (24) inches of backfill is in place, and again at completion of Project.
    1. Submit separate report for each system inspection.
    2. Defects requiring correction include the following:
    3.
        a. Alignment: Less than full diameter of inside of pipe is visible between structures.
        b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5% of piping diameter.
        c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
        d. Infiltration: Water leakage into piping.
        e. Exfiltration: Water leakage from or around piping.
    4. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
    5. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
    1. Do not enclose, cover, or put into service before inspection and approval.

2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least twenty four (24) hours' advance notice.
4. Submit separate report for each test.
5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
6.
    a. Fill sewer piping with water. Test with pressure of at least ten (10) foot head of water, and maintain such pressure without leakage for at least four (4) hours.
    b. Close openings in system and fill with water.
    c. Purge air and refill with water.
    d. Disconnect water supply.
    e. Test and inspect joints for leaks.
7. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
    a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
    b. Option: Test concrete gravity sewer piping according to ASTM C 924.
8. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than one and one half (1-1/2) times the maximum system operating pressure, but not less than 150 psig.
9.
    a. Ductile Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
    b. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
10. Manholes: Perform hydraulic test according to ASTM C 969.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION 221113

SECTION 221316 – SANITARY, CHEMICAL, AND VENT PIPING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 22.

1.2 SUMMARY

A. This section includes the requirements for sanitary, chemical and vent piping and specialties above ground within the building, and sanitary piping below the floor slab to five (5) feet outside the building, and includes the following**:**
   1. Cast iron hub and spigot pipe and fittings.
   2. Specialty pipe fittings.
   3. Floor drains.
   4. Backwater valves.
   5. Cleanouts.
   6. Drainage specialties.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

   1. Soil, Waste, and Vent Piping: Ten (10) foot head of water.

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.4 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, and warranty information.

B. LEED Submittals:

   1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
   2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For drainage system. Include plans, elevations, sections, and details.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

1.6 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

B. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

C. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: The installer shall be a qualified licensed installer within the jurisdiction and familiar with the installation of the pipes and fittings specified herein for each piping system.

B. Material Labels: Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. Compliance: Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

D. Source Limitations: Obtain pipe and fittings from the same manufacturer for each pipe system.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than ten (10) days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

1.9 WARRANTY/GUARENTEE

A. See Division 22, Specification Section "Basic Mechanical Requirements – Plumbing" for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Material Design and Selection: Sanitary, Chemical and Vent pipes, fittings, and specialties shall be designed and selected, for the intended use, in accordance with the sizes on the drawings and the requirements of this specification.

B. Acceptable Manufacturers:

1. Cast Iron Piping Systems: The basic of design is Charlotte Pipe. Other acceptable manufacturers are:

   a. Tyler Pipe Company.

2. Floor Drains, Cleanouts: The basis of design is Zurn Plumbing Products. Other acceptable manufacturers are:

   a. Josam Company
   b. J.R. Smith Manufacturing Company
   c. MIFAB Inc.

3. Specialty Pipe Fittings: The basis of design is Watts Plumbing Products. Other acceptable manufacturers are:

   a. Wilkins.
   b. Capitol Manufacturing Company
   c. Fernco Inc.

2.2 SANITARY AND VENT PIPE APPLICATION

A. General Application: All pipe, fittings and joint methods shall be as specified below. The listed manufacturers, materials and model numbers below are the basis of design. For this application, Sanitary, Chemical and Vent Piping Systems are defined as follows:

1. Sanitary System: Includes Waste and Vent Piping serving non laboratory areas of the project and/or the building.

B. Sanitary and Vent Pipe Material Application Schedule:

1. See application schedule below:

Pipe System	Pipe Material	Fitting Material	Joint Material
Sanitary and Vent Systems Below Grade to 5 feet beyond the building.	Cast Iron: Service Weight, Hub and Spigot, 2 inch – 15 inch, ASTM A74	Cast Iron: Service Weight, Hub and Spigot, ASTM A74	Hub and Spigot, Lead and Oakum joints or compression gaskets, ASTM C 564
	All Cast Iron Soil Pipe and Fittings shall be marke with the Collective Trade Mark of the Cast Iron So Pipe Institute (CISPI) and listed by NSF Internatio		
Non Laboratory Sanitary and Vent Systems above ground within the building	Cast Iron: Service Weight, No Hub, 2 inch – 10 inch C15P1-301.	Cast Iron: Service Weight, No Hub, C15P1-301	Couplings: Heavy Duty Type 304 Stainless Steel, ASTM 564 neoprene gasket, 3 inch wide for piping less than 4 inch and 4 inch wide for piping 4 inch and larger.

2.3 FLOOR DRAINS

A. Cast Iron Floor Drain - FD – 1:

1. Model: Zurn Z415
2. Standard: ASME A112.6.3.
3. Pattern: Floor Drain.
4. Body Material: Cast Iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom, Threaded, Spigot or No Hub.
9. Backwater Valve: Not Required.
10. Coating – Interior and Exterior Exposed Surfaces: Acid resistant enamel.
11. Sediment Bucket: Not Required.
12. Top of Strainer Material: Nickle Bronze.
13. Top of Strainer Finish: Nickle Bronze.
14. Top Shape: Round.
15. Strainer Dimension: Eight (8) inches.

16. Top Loading Classification: Light Duty.
17. Funnel: Not Required.
18. Inlet Fitting: Gray Iron.
19. Trap Material: Cast Iron.
20. Trap Pattern: 'P' Trap.
21. Trap Feature: Trap primer connection.

2.4 CLEANOUTS

A. Exposed Metal Cleanouts:

1. ASME A112.36.2M, Cast-Iron Cleanouts with straight threads and gasket seal or taper threads for plug flashing flange and clamping ring, and a brass closure plug. Cleanouts for installation in floors not having membrane waterproofing may be furnished without clamping ring:
2. Cleanouts in concrete floors:

    a. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Model No. Z-1400 style to suit floor finish with round scoriated top or comparable product by one of the following:

3. Cleanouts in Finished Floors:

    a. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Model No. ZN-1400 style to suit floor finish with recessed top for tile or carpet, or comparable product.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 or 3/4 side inlet.

C. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

D. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Specification Section "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of sanitary, chemical and vent piping systems. Install sanitary, chemical and vent piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install chemical and vent piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install chemical and vent piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install chemical and vent piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install chemical and vent piping to permit valve servicing.

F. Install chemical and vent piping at indicated slopes.

G. Install chemical and vent piping free of sags and bends.

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

I. Install chemical and vent piping to allow application of insulation.

J. Make changes in direction for sanitary, chemical and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two (2) fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install sanitary, chemical and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: 2% downward in direction of flow for piping NPS 3 and smaller; 1% downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2% downward in direction of flow.
3. Vent Piping: 1% down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Specification Section "Sleeves, Sleeve Seals and Escutcheons for Plumbing Piping."

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Specification Section "Sleeves, Sleeve Seals and Escutcheons for Plumbing Piping."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Specification Section "Sleeve, Sleeve Seals and Escutcheons for Plumbing Piping."

3.3 INSTALLATION

A. Assemble open drain fittings and install with top of hub one (1) inch above floor.

B. Install deep-seal traps on floor drains and other waste outlets, if indicated.

C. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

D. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

E. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

F. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
2. Install drains in sanitary drainage gravity-flow piping.
3. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
4. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
5. Position floor drains for easy access and maintenance.
6. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

a. Radius, Thirty (30) Inches or Less: Equivalent to one (1) percent slope, but not less than one quarter (1/4) inch total depression.
b. Radius, Thirty (30) to sixty (60) Inches: Equivalent to one (1) percent slope.
c. Radius, Sixty (60) Inches or Larger: Equivalent to one (1) percent slope, but not greater than one (1) inch total depression.

7. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
8. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

3.4 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

3.5 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Unshielded, nonpressure transition couplings.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Specification Section "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least twenty four (24) hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

3.9 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.10 CONNECTIONS

A. Install piping adjacent to equipment to allow service and maintenance.

B. Connect wiring according to Division 26 Specification Section "Low-Voltage Electrical Power Conductors and Cables."

3.11 LEAK TEST PIPING SYSTEMS:

A. See Division 22 Specification Section “Leak Test Plumbing Piping Systems” for testing requirements.

END OF SECTION 221316

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SECTION 230000 – BASIC MECHANICAL REQUIREMENTS – HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01Specification Sections, apply to this section and all other sections of Division 23.

REVIEW ALL SECTIONS OF DIVISION 1 TO ENSURE THAT REQUIREMENTS FOR MECHANICAL INSTALLATIONS ARE ADEQUATELY COVERED. REQUIREMENTS COVERED IN DIVISION 1 SHOULD NOT BE REPEATED IN THIS SECTION. THIS SECTION COVERS ONLY REQUIREMENTS PECULIAR TO DIVISION 15 AND COMMON TO MORE THAN ONE SECTION OF DIVISION 15. REFER TO EVALUATIONS AND SPEC COORD SHEETS FOR FURTHER DISCUSSION.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements, as well as the following basic mechanical materials and methods:

1. Codes, organizations, standards, and abbreviations
2. Submittals
3. Site visit
4. Outages
5. Variances
6. Cutting, welding and burning
7. Performance requirements
8. Material and equipment
9. Related work
10. Contract drawings.
11. Coordination
12. Demolition
13. Fire safe materials
14. UL requirements
15. Coordination drawings
16. Construction record documents.
17. Operation and maintenance manuals
18. Fire stops and smoke seals
19. Guarantee / Warranty
20. Pipe and equipment roof curbs and supports
21. Equipment roughins
22. Cutting and patching
23. Installation requirements common to equipment specification sections
24. Excavation and back fill
25. Temporary service

26. Demonstrations
27. Final cleaning

1.3 CODES, ORGANIZATIONS, STANDARDS AND ABBRIVIATIONS

A. Codes: All material and equipment provided and installed as part of these construction documents shall be in compliance with the latest edition of the following codes as adapted by the State of Maryland for the following:

1. IBC: International Building Code
2. IMC: International Mechanical Code
3. IECC: International Energy Conservation Code
4. NEC: National Electrical Code
5. NFPA 90A: Standard for the Installation of Air Conditioning and Ventilation Systems
6. NFPA 90B: Standard for the Installation of Warm Air Heating and Air Conditioning Systems
7. NFPA 101: Life Safety Code
8. PHCC: National Standard Plumbing Code Illustrated

B. Organizations and Standards: The following list of organizations and standards are referenced in the HVAC Specification Sections and are included here for reference:

1. AABC: Associated Air Balance Council
2. ADC: Air Diffusion Council
3. AEC: Architecture, Engineering and Construction
4. AGA: American Gas Association
5. AHRI: Air Conditioning, Heating and Refrigeration Institute
6. AMCA: Air Moving and Conditioning Association
7. ANSI: American National Standards Institute
8. API: American Petroleum Institute
9. ARI: Air Conditioning and Refrigeration Institute
10. ASCE: American Society of Civil Engineers
11. ASCE-SEI: American Society of Civil Engineers - Structural Engineering Institute
12. ASHRAE- American Society of Heating, Refrigerating and Air Conditioning Engineers
13. ASME: American Society of Mechanical Engineers
14. ASTM: American Society for Testing and Materials
15. AWS: American Welding Society
16. AWWA: American Water Works Association
17. BAS: Building Automation System
18. CFR: Code of Federal Regulations
19. CGA: Compressed Gas Association
20. CS: Commercial Standard
21. CSA: Canadian Standards Association
22. CTI STD: Cooling Technology Institute - Standard

23. CTI ATC: Cooling Technology Institute – Acceptable Test Code
24. EJMA: Expansion Joint Manufacturers Association
25. EPA: Environmental Protection Agency
26. FM: Facilities Management
27. FMG: Factory Mutual Global
28. FSA: Fuel Sealing Association
29. FSA – NMEJ: Fuel Sealing Association - Non-Metallic Expansion Joint
30. IAPMO: International Association of Plumbing and Mechanical Officials
31. IBR: Institute of Boiler and Radiator Manufacturers
32. ICC: International Code Council
33. ICC–ES: International Conference on Computational & Experimental Engineering and Sciences
34. IEC: International Electrotechnical Commission
35. IEEE: Institute of Electrical and Electronics Engineers
36. IESNA: Illuminating Engineering Society of North America
37. ISO: International Organization for Standardization
38. ITT: International Telephone & Telegraph Corporation
39. MOSHA- Maryland Occupational Safety and Health Administration
40. MSHA: Mine Safety and Health Administration
41. MSS: Manufacturers Standardization Society
42. MSSP: Manufacturers Standards Society of the Valve and Fittings Industry
43. MSS SP: Manufacturers Standardization Society Standard Practice
44. NADCA: National Air Duct Cleaners Association
45. NAIMA: North American Insulation Manufacturers Association.
46. NAIMA – AH: North American Insulation Manufacturers Association – Air Handling
47. NEBB: National Environmental Balancing Bureau
48. NEC: National Electric Code
49. NEMA: National Electrical Manufacturers Association
50. NEMA – ICS: National Electrical Manufacturers Association – Industrial Control and Systems
51. NEMA – KS: National Electrical Manufacturers Association – Kansas
52. NEMA – MG: National Electrical Manufacturers Association – Motors & Generators
53. NFPA: National Fire Protection Association
54. NICET: National Institute for Certification in Engineering Technologies
55. NIOSH: National Institute for Occupational Safety and Health
56. OSHA - Occupational Safety and Health Administration
57. SE: System Engineering
58. SEI: Software Engineering Institute
59. SMACNA- Sheet Metal and Air Conditioning Contractors National Association
60. TEMA: Tubular Exchanger Manufacturers Association
61. ULC: Underwriters' Laboratories – Canada
62. UM: University of Maryland
63. UMB: University of Maryland, Baltimore
64. UMB-A/E: University of Maryland, Baltimore – Architect/Engineer

65. UMB-FM: University of Maryland, Baltimore – Facilities Management
66. UMB-PM: University of Maryland, Baltimore – Project Manager

C. Abbreviations: The following list of abbreviations are referenced in the HVAC Specification Sections and are included here for reference:

1. A/C: Air Conditioning
2. ADA: American Disability Act
3. ASJ: All Service Jacket
4. ATC: Automatic temperature Control
5. BACnet: Building Automation and Control Networks
6. BACnet IP: Internet Protocol
7. BACnet MSTP: Master Slave Token Passing
8. BACnet TCP: Transmission Control Protocol
9. BAS: Building Automation System
10. BMS: Building Management System
11. BTU: British Thermal Unit
12. CAD: Computer Aided Design
13. CD-ROM: Compact Disk – Read Only Material
14. CFC: Chlorofluorocarbon
15. CFM: Cubic Feet per Minute
16. CM: Construction Manager
17. Corp: Corporation
18. CV: Coefficient of Variation, Constant Volume
19. CWP: Cold Working Pressure
20. ºC: Degree Celsius
21. ºF: Degree Fahrenheit
22. DDC: Direct Digital Control
23. DIA: Diameter
24. DOC: Document
25. DP: Differential Pressure
26. Dwg: Drawing
27. EEPROM: Electrically Erasable, Programmable Read-Only Memory
28. EMT: Electrical Metallic Tubing
29. EDPM: Ethylene Propylene Diene Terpolymer Rubber
30. FIT: Fast Installation Technique
31. FLN: Floor Local Network
32. FNPT: Female National Pipe Thread
33. FPM: Feet Per Minute
34. FRP: Fiberglass Reinforced Pipe
35. FSK: Foil Scrim Kraft
36. FTU: Fin Tube
37. Ft.^{2}: Square Feet
38. GAL: Gallon(s)
39. GETU: General Exhaust Terminal Unit
40. GFI: Ground Fault Interrupter

41. GPM: Gallons Per Minute
42. HCFC: Hydrochlorofluorocarbons
43. HEPA: High Efficiency Particulate Absorption
44. Hr: Hour
45. H_g: Mercury
46. HP: Horse Power
47. HVAC: Heating Ventilation and Air Conditioning
48. H_z: Hertz
49. IBC: International Building Code
50. IEQ: Indoor Environmental Quality
51. Inc: Incorporated
52. ID: Inside Diameter
53. IN: Inches
54. Khz: Kilohertz
55. KVA: Kilo Volt Ampere
56. KVAR: Kilo Volt Amperes, Reactive
57. KVARH: Kilo Volt Amps Reactive Hours
58. kW: Kilowatt
59. LAN: Local Area Network
60. Lb: Pound
61. Lbf/inch: Pound Force per Inch
62. Lbs: Pounds
63. LCD: Liquid Crystal Display
64. LED: Light Emitting Diode
65. mA: Milli Ampere
66. mL: Milli Liter
67. MAX: Maximum
68. MERV: Minimum Efficiency Rating Value
69. MIN: Minimum
70. MPa: Megapascal
71. N/A: Not Applicable
72. NBR: Nitrile Butadiene Rubber
73. NEC: National Electric Code
74. NG: Natural Gas
75. NMEJ: Non-Metallic Expansion Joint
76. No.: Number
77. NOM: Nominal
78. NPS: Nominal Pipe Size
79. NPT: National Pipe Thread
80. NRC: Noise Reduction Coefficient
81. OC: On Center
82. OD: Outside Diameter
83. ODP: Open Drip Proof
84. OZ: Ounce
85. PD: Pressure Drop
86. Pdf: Portable Document Format

87. pH: Potassium Hydrogen
88. PPM: Parts per Million
89. PPS: Plastic Pipe Systems
90. PSI: Pounds per Square Inch
91. PSIG: Pounds per Square Inch Gage
92. P/T: Pressure/Temperature
93. PTFE: Polytetraflouroethylene
94. PVC: Polyvinyl Chloride
95. RPM: Revolutions per Minute
96. RPTFE: Reinforced PolyTetraFluoroEthylene
97. S/S: Stainless Steel
98. STC: Sound Transmission Class
99. STU: Supply Terminal Unit
100. Sq.yd.: Square Yard
101. TAB: Testing, Adjusting, and Balancing
102. TEAO: Totally Enclosed Air Over Enclosure
103. TEC: Terminal Equipment Controller
104. TENV: Totally Enclosed Non Ventilating Enclosure
105. TFE: Tetrafluoroethylene, Trifluoroethanol?
106. TORR: Unit of Pressure Equal to 1/760 Atmosphere
107. TRU: Terminal Reheat Unit
108. TSS: Total Suspended Solids
109. UH: Unit Heater
110. US: United States
111. USA: United States of America
112. USB: Universal Serial Bus
113. UPS: Uninterrupted Power Supply
114. UV: Ultraviolet
115. V: Volt
116. VAV: Variable Air Volume
117. VOC: Volatile Organic Compounds
118. VSD: Variable Speed Drive
119. WG: Water Gage

1.4 SUBMITTALS

A. General: For general requirements see Architectural Specification Division 01 Section "Submittals".

B. HVAC Submittals: Provide submittals for all material, equipment and/or supports as specified in Division 23 and where indicated on the drawings and details. For material and product data submission requirements see Division 23 Specification Sections. At a minimum the following submittals shall be provided as required by the project:

1. Pipe, fittings and accessories for each system.
2. Valves, strainers and unions for each system.

3. Insulation (pipe, duct and equipment).
4. Hangers and supports.
5. AHU's.
6. Split system AC units.
7. Ventilation fans.
8. Terminal heating units (UH).
9. Air terminal units (STU, GETU, FHETU).
10. Air Devices.
11. Duct systems.
12. Building automation system.
13. Identification (labels, tags valve schedule).
14. Equipment supports.

C. Submittal File Format: File formats for each submittal shall be electronically as follows:

1. Product Data File: "pdf" file format.
2. Drawings: "pdf" and "dwg" formats.
3. Coordinated Drawings: "pdf" or "dwg" file formats.
4. Schedules: "xl" file format.

1.5 SITE VISIT

A. Prior to preparing the bid, the HVAC mechanical subcontractor shall visit the site and become familiar with all existing conditions. Make all necessary investigations as to locations of utilities and all other matters which can affect the work. No additional compensation will be made to the contractor as a result of his failure to familiarize himself with the existing conditions under which the work must be performed.

1.6 OUTAGES

A. For all work requiring an outage, the HVAC mechanical subcontractor shall submit an outage request to the UMB Project Manager, using the UMB Standard Request for Outage Form which is available through the UMB Design and Construction Web Site at http://www.umaryland.edu/designandconstruction/, under the Documents Link. The existing HVAC system shall remain operational unless turned off by University personnel during the construction of the project.

B. Unless otherwise specified, outages of any services required for the performance of this contract and affecting areas other than the immediate work area shall be scheduled at least ten days (10) days in advance with the Office of Facilities Management. All such outages shall be performed on other than normal duty hours.

C. All HVAC outages which will interfere with the normal use of the building in any manner shall be done at such times as shall be mutually agreed upon by the contractor and the Office of Facilities Management.

D. The HVAC contractor shall include in his price the cost of all premium time required for outages and other work which interferes with the normal use of the building, which will be performed, in most cases, during other than normal work time and at the convenience of the University.

E. The operation of HVAC valves or switches; required to achieve an outage must be accomplished by University personnel only. Prospective subcontractors under this section are cautioned that the unauthorized operation of HVAC valves, power switches, or other control devices by their personnel can result in extremely serious consequences for which the contractor will be held accountable.

1.7 VARIANCES

A. Where variances occur between the drawings and specifications or within either document itself, the item or arrangement of better quality, greater quantity or higher cost shall be included in the contract price. The Engineer shall decide on the item and manner in which the work shall be provided.

1.8 CUTTING, WELDING, BURNING

A. Before the contractor and/or any sub-contractor commences any cutting, welding, burning, brazing (pipe sweating), the contractor shall obtain a hot work permit from Environmental Health and Safety at extension 1-410-706-3490.

B. The hot work permit copy shall remain on the job site at the hot work location until such work is completed at which time the permit shall be returned to Environmental Health and Safety.

1.9 PERFORMANCE REQUIREMENTS

A. Contract drawings are generally diagrammatic and do not indicate all offsets, fittings, transitions, access panels and other specialties required.

B. Arrange HVAC piping, ductwork, equipment and other work generally as shown on the contract drawings, providing proper clearances and access.

C. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawing submittal for approval in accordance with Submittals specified below.

D. The Architect may make reasonable changes in location of equipment piping and ductwork up to the time of rough-in or fabrication.

1.10 MATERIALS AND EQUIPMENT

A. The contract drawings and system performances have been designed on the basis of using the particular manufacturer's products specified or scheduled on the contract drawings.

B. Products of other manufacturer's listed in the specification shall be permitted provided as follows:

1. Products meet all of the requirements of the specifications.
2. Make, without additional cost to the Owner, all adjustments for deviations, such that the final installation is complete and functions as the basis of design product is intended.

C. Products with dimensions or other characteristics different from the basis of design product that render their use impractical or cause functional fit, access, or connection problems, shall not be acceptable.

1.11 COORDINATION, SEQUENCING AND SCHEDULING

REVISE ITEMS IN THE FOLLOWING EXAMPLES TO COVER PROJECT REQUIREMENTS.

A. Coordinate HVAC systems, equipment, and materials installation with other building components.

B. Utilities: Coordinate connection of HVAC systems with exterior underground services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

C. Chases: Arrange for chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

D. Sleeves: Coordinate the installation of required supporting devices and set sleeves in poured in place concrete and other structural components as they are constructed.

E. Sequencing: Sequence, coordinate, and integrate installations of HVAC materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

F. Electrical Services: Coordinate connection of electrical services.

G. Access: Coordinate requirements for access panels and doors where HVAC items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Architectural Specification Section "Access Doors."

H. Scheduling: Schedule and coordinate the delivery of material and equipment with other trades to avoid delivery conflicts.

1.12 FIRE SAFE MATERIALS

A. Unless otherwise indicated, materials shall conform to UL, NFPA or ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of twenty five (25) and smoke developed of fifty (50).

1.13 UNDERWRITER'S LABORATORY (UL) REQUIREMENTS

A. All equipment containing electrical components and provided as part of the mechanical specifications shall bear the Underwriter's Laboratory (UL) label, as a complete packaged system.

1. Equipment not provided with a UL label shall be tested in the field, certified and provided with a UL label at the installer's expense.
2. Field testing shall be performed by a testing agency approved by the authority having jurisdiction.

REFER TO DIVISION 1 SECTION "PROJECT COORDINATION," TEXT AND EVALUATIONS, FOR GENERAL REQUIREMENTS BEFORE EDITING THIS ARTICLE. SPECIFY ONLY MECHANICAL-RELATED REQUIREMENTS HERE.

1.14 CONSTRUCTION RECORD DOCUMENTS

A. The mechanical contractor shall maintain a set of construction record documents during the construction period in accordance with Specification Division 01 Section "Project Closeout".

B. REFER TO DIVISION 1 SECTION "PROJECT CLOSEOUT," TEXT AND EVALUATIONS, FOR GENERAL REQUIREMENTS BEFORE EDITING THIS ARTICLE. SPECIFY ONLY MECHANICAL-RELATED REQUIREMENTS HERE.

1.15 OPERATION AND MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Specification Division 01 Section "Project Closeout."

1.16 FIRE STOPS & SMOKE SEALS

A. Fire stops and smoke seals shall be provided by one (1) manufacturer for all trades. See Architectural Specification Division 7 for requirements.

B. Provide fire stops and smoke seals for all mechanical services installed and existing services in the project area that pass through fire rated partitions, wall, floors etc. Services shall include all ductwork, conduit, metal and plastic piping, cables, etc. The area around penetrations including any voids between them must be filled in and sealed with UL fire rated materials equal to the adjoining materials. All fire stop insulation devices and sealants shall maintain the fire resistance integrity of the floor, wall partition, etc. and meet ASTM 814-83 F&T rating for time, hours and temperature rise. All fire stopping and sealants shall allow for expansion and contraction movement without pumping free of

openings. Provide U. L. System Numbers in product submittals for each Fire Stop & Smoke Seal Application.

C. The installer of firestop and smoke seal materials shall be a firm licensed or otherwise approved by the manufacturer of the materials and have at least five (5) years experience installing firestop and smoke seal materials. Installer shall comply with the material manufacturer's recommendations and installation requirements and ASTM and applicable code requirements.

D. All fire stop and smoke seal materials shall be as manufactured by any one of the following manufacturers:

1. Specified Technologies Inc. (STI)
2. DOW Corning Corp.
3. 3M Inc.
4. Hilti REFER TO DIVISION 1 SECTION "MATERIALS AND EQUIPMENT," TEXT AND EVALUATIONS, FOR GENERAL REQUIREMENTS BEFORE EDITING THIS ARTICLE. SPECIFY ONLY MECHANICAL-RELATED REQUIREMENTS HERE.

1.17 WARRANTY/GUARANTEE

A. All materials, equipment, etc. provided by the general contractor and/or his subcontractors shall be warranted and guaranteed to be free from defects in workmanship and materials for a period of two (2) years from the date of substantial completion and acceptance of work by UMB. Any defects in workmanship, materials, or performance which appear within the guarantee period shall be corrected by the contractor without cost to the owner, within a reasonable time, to be specified by UMB. In default thereof, owner may have such work done and charge the cost of same to the contractor. In addition to the above statement the Warranty/Guarantee Period shall also include all labor cost related to all warranty work. For compressorized equipment include an additional three (3) year Warranty/Guarantee Period.

PART 2 – PRODUCTS

2.1 LISTED MANUFACTURERS:

A. Listed Manufacturers: The listed manufacturers indicated in Part 2 of each specification section as the basis of design represents the minimum level of quality for materials and equipment that is acceptable to UMB. Unless otherwise indicated in each specification section, contractors may submit material and equipment by non listed manufacturers provided said submittals meet all of the requirements of these specifications. All submitted materials and equipment are subject to approval by the A/E and UMB.

B. Approved Equal Equipment Layouts: The equipment layouts and the related mechanical and electrical service connections, access space and supports indicated on the construction documents represent equipment provided by the specified basis of design manufacturer and model number. When the successful bidder chooses to provide "or approved equal" equipment by one (1) of the other listed manufacturers in the specifications, the bidder shall be responsible for providing all adjustments and modifications to the services necessary to make connections to the equipment, the bidder shall be responsible for installing the equipment such that all required clear access space is maintained, and the bidder shall be responsible for providing all adjustments and modifications to the equipment mounting and supports. All adjustments and modifications shall be provided by the bidder and appropriate subcontractors at no additional cost to the project.

2.2 CONCRETE AND MASONRY WORK

A. Concrete: 3,500 psi compressive strength after twenty eight (28) days.

B. Grout shall be non-shrink, high strength type, free of iron or chlorides and suitable for use in contact with all metals, without caps or other protective finishes.

2.3 GROUT

A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.

1. Characteristics: Post hardening, volume adjusting, dry, hydraulic cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5,000-psi (34.50MPa), twenty eight (28) day compressive strength.
3. Packaging: Premixed and factory-packaged.

2.4 COMBINATION MOTOR STARTERS, VFD'S, AND CONTROLLERS – HVAC EQUIPMENT

A. Combination motor starters, VFD's and/or controllers shall be provided for all motors serving HVAC equipment as follows:

1. Skid Mounted Equipment: Combination motor starters, VFD's and/or controllers shall be provided by the equipment manufacturer as part of Division 23.
2. Non Skid Mounted Equipment: Combination motor starters, VFD's and/or controllers shall be provided as part of Division 26.

PART 3 - EXECUTION

3.1 EQUIPMENT ROUGH IN

A. Verify final locations for rough ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications included in the architectural, mechanical, and electrical specifications for equipment rough in requirements.

3.2 MECHANICAL INSTALLATIONS - HVAC

A. Verify all dimensions by field measurements.

B. Where HVAC systems, materials and equipment are intended for overhead installation, and where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible. Notify UMB - PM prior to installation of HVAC components when headroom is less than 7'-6" and/or where existing system components will be below the new finished ceiling height. Notification shall be through the “RFI” process.

C. Install HVAC systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, identify the conflict and submit and “RFI” for each conflict to the Architect.

D. Install HVAC systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.

E. REFER TO DRAWING COORDINATION CHECKLIST.Install HVAC equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

F. Install access panel or doors where units are concealed behind finished surfaces. Access panels and doors are specified in the Architectural Specifications.

G. Install HVAC systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

H. The contractor shall confirm that all pressure vessels are installed in full compliance with the requirements of the Sate Inspector’s Office for Boilers and Pressure Vessels. Refer to “Closeout Procedures” in this Section for additional requirements.REFER TO DIVISION 1 SECTION "CUTTING AND PATCHING," TEXT AND EVALUATIONS, FOR GENERAL REQUIREMENTS BEFORE EDITING THIS ARTICLE. SPECIFY ONLY MECHANICAL-RELATED REQUIREMENTS HERE.

3.3 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Specification Division 01 Section "Cutting and Patching" In addition to the requirements specified in Specification Division 01, the following requirements apply:

1. Patch Materials: Patch finished surfaces and building components using new materials specified for the original installation and using experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

3.4 PAINTING AND FINISHING

A. Refer to Architectural Specification Section "Painting" for field painting requirements.

B. Damage and Touch Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

C. Do not paint manufacturer's labels or tags.

3.5 CONCRETE BASES
COORDINATE CONCRETE WORK WITH DIVISION 3.

A. Construct concrete equipment bases of dimensions indicated, but not less than four (4) inches (100 mm) larger than supported unit in both directions. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3,000-psi (20.70MPa), twenty eight (28) day compressive strength concrete and reinforcement bars as specified in the architectural specifications.

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS D1.1 "Structural Welding Code Steel."

3.7 PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls and interior waterproof construction.

B. Furnish and install drains, curbs, vent assemblies, sleeves, flashing, etc. specifically designed for application to the particular construction. Install system in accordance with the roofing manufacturer's instructions.

3.8 EXCAVATION AND BACKFILLING

A. General: Perform all necessary excavation and backfilling necessary for the installation of underground HVAC services as part of Division 23 in accordance with the architectural specifications.

3.9 CLEANING AND FINISHES

A. Clean surfaces prior to application of insulation, adhesives, coating, and paint.

B. Provide factory applied finish where specified.

C. Protect all finishes, and restore all finishes to their original condition if damaged as a result of work installed as part of the mechanical specifications.

D. Remove all construction marking and writing from exposed equipment, ductwork, piping and building surfaces.

3.10 LINTELS

A. Lintels shall be provided for openings in masonry, brick, concrete, etc. walls to accommodate work of this division.

1. Lintels shall be provided under this division when not being provided under other divisions. Lintels shall be approved by the Architect.

3.11 ELECTRICAL REQUIREMENTS

A. Unless otherwise indicated, furnish and install control and interlock wiring for the equipment furnished under this division. In general, power wiring and motor starting equipment will be provided as specified in the electrical specifications.

1. Where the electrical requirements of the equipment furnished differ from the provisions made in the electrical specifications, make the necessary allowances as part of the mechanical specifications.
2. Where no electrical provisions are included in the electrical specifications, include all necessary electrical work as part of the mechanical specifications.

B. All electrical work performed as part of the mechanical specifications shall be provided in accordance with the electrical specifications.

3.12 PROVISIONS FOR ACCESS

A. Furnish and install adequate access to all HVAC and plumbing components. The following list shall be used as a guide only:

1. Equipment
2. Valves

3. Dampers and operators
4. Filters
5. Heating and air conditioning units
6. Controls
7. ATC panels
8. Heating and cooling coils
9. Low point drains

B. Access shall be adequate as determined by the Architect.

C. Refer to contract drawings where access panels have been specifically located.

D. Provide additional access panels for adequate access as indicated in paragraph 'A' above.

E. Where access is by means of lift out ceiling tiles or panels mark each access panel using small color coded or numbered tabs. Provide an index chart for identification. Place markers in corner of tile.

3.13 PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls and interior waterproof construction.

B. Furnish and install drains, curbs, vent assemblies, sleeves, flashing, etc. specifically designed for application to the particular construction. Install system in accordance with the roofing manufacturer's instructions.

3.14 OPERATION OF EQUIPMENT

A. Clean all systems and equipment prior to initial operation for testing and balancing.

B. Do not operate equipment unless all proper safety devices or controls are operational.

C. Provide all maintenance and service for equipment which is operated during construction.

D. Where specified and otherwise required, provide the services of a manufacturer's factory trained service organization to start the equipment.

3.15 TEMPORARY SERVICE AND EQUIPMENT USE

A. Temporary Service: Unless temporary services are required as part of the project, do not use HVAC systems for temporary services during construction unless authorized in writing by the Architect and/or UMB.

B. Equipment Use: Where such authorization is granted, temporary use of new and or existing equipment shall not limit or otherwise affect warranties or guarantees covering

new equipment. Where equipment is used by the contractor the contractor shall perform all required preventive maintenance on the equipment during the construction period. Upon completion of work, clean and restore all new and/or existing equipment to new condition and replace all filters as necessary.

3.16 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of equipment and systems to Owner's personnel a minimum two (2) weeks prior to date of final inspection.

1. For equipment requiring seasonal operation, perform instructions for other seasons at the same time.
2. Training period shall be performed within one (1), two (2) week period.

B. Use operation and maintenance manuals and video as basis of instruction. Review contents of manual and video with personnel in detail to explain all aspects of operation and maintenance.

C. Demonstrate the following:

1. Start up.
2. Operation.
3. Control.
4. Adjustment.
5. Trouble shooting.
6. Servicing.
7. Maintenance.
8. Shutdown.

D. Provide at least forty (40) hours straight time instruction to the operating personnel.

1. This instruction period shall consist of not less than five (5) eight (8) hour days.
2. Time of instruction shall be designated by the Owner.
3. This instruction shall be in addition to instructional requirements of specific equipment specified elsewhere in the mechanical specifications.

3.17 LUBRICATION

A. All bearings, motors and all equipment requiring lubrication shall be provided with accessible fittings.

B. Before turning over the equipment to the Owner, the Installer shall provide the following:

1. Fully lubricate each item of equipment.
2. Provide one (1) year's supply of lubricant for each type of lubricant.

3. Provide complete written lubricating instructions, together with diagram locating the points requiring lubrication.

C. Motors and equipment shall be provided with grease lubricated roller or ball bearings with Alemite or equal extended grease fittings and drain plugs.

3.18 WALL AND FLOOR PENETRATION

A. All penetrations of partitions, walls and floors by ducts, piping or conduit under Specification Division 23 shall be sealed and caulked. Provide U.L. listed fire stopping systems at penetrations through fire walls as specified in the architectural specifications.

3.19 EQUIPMENT PROVIDED UNDER ANOTHER DIVISION AND BY OTHERS

A. The Installer of products under Specification Division 23 shall make all system connections required to equipment furnished and installed under another division and by others.

B. It shall be the responsibility of the Installer to obtain all necessary data from the equipment supplied under other Divisions.

3.20 CONSTRUCTION RECORD DRAWINGS

A. As the work progresses, the contractor shall record on one (1) set of prints, the installed locations, sizes, and depths of pipes, services, equipment, etc. which may differ from the approved contract drawings.

B. Upon completion of the HVAC installations, the installer shall deliver to the Architect construction manager one (1) complete set of marked-up blueprints of the HVAC contract drawings. The construction manager shall compile the mark up prints into a composite set and transmit the set the architect who shall incorporate the mark ups into the record drawing electronic file.

1. The mark-ups shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design.

C. At a minimum include the following installed conditions:

1. Location of all shut off valves, drain valves, and balancing valves with assigned valve tag numbers.
2. Show the location of concealed material and/or equipment requiring service such as strainers, traps, localized A/C units, control valves and/or expansion compensators.
3. Actual entering/leaving invert elevations for steam, and chilled water services for the building.

3.21 CLOSEOUT PROCEDURES

A. Operating and Maintenance Instructions: Submit Complete Package At Least Two (2) Months Prior To Substantial Completion. Arrange for each installer of equipment that requires regular maintenance to meet with the Owner's personnel to provide instruction in proper operation and maintenance. If installers are not experienced in procedures, provide instruction by manufacturer's representatives. Include a detailed review of the following items:
   1. Maintenance manuals, including a customized list of preventive maintenance items and annual schedule for maintenance.
   2. Record documents.
   3. Complete inventory of spare parts and materials.
   4. Tools.
   5. Lubricants.
   6. Fuels.
   7. Identification systems.
   8. Control sequences.
   9. Hazards.
   10. Cleaning.
   11. Warranties and bonds.
   12. Maintenance agreements and similar continuing commitments.

B. As part of instruction for operating equipment, demonstrate the following procedures:

   1. Start up.
   2. Shut down.
   3. Emergency operations.
   4. Noise and vibration adjustments.
   5. Safety procedures.
   6. Economy and efficiency adjustments.
   7. Effective energy utilization.

C. Pressure Vessel Inspections by the State of Maryland: For the purpose of obtaining and having UM buildings insured by any commercial insurance carrier, the contractor shall arrange for the inspection of all pressure vessels installed during construction. The contractor shall contact the Office of Boiler and Pressure Vessel Inspections of the Department of Labor, Licensing and Regulations (DLLR), State of Maryland, and arrange for the inspections. The DLLR shall be notified at least thirty (30) days prior to installation. After such inspections are carried out by the State Inspector’s office, Certificates of Compliance will be issued to the contractor of record to be turned over to the Owner’s representative for compliance with current insurance regulations as part of the Project Documents. Examples of pressure vessels include boilers, heat exchangers, converters, expansion tanks, water heaters, hot water generators and storage tanks. Chillers are excluded and are covered under ASHRAE Guidelines.

3.22 FINAL CLEANING

A. General: General cleaning during construction is required by the General Conditions as indicated in Division 01 Specification Section "Temporary Facilities."

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.

C. Remove all mechanical clipping, wiring, nuts, bolts, etc. left on top of ceilings and ceiling tiles.

3.23 PROJECT PUNCH OUT

A. Architect/Engineer will perform punch out reviews and will provide the Contractor with a list of punch list items to be completed before contract close out. Each and every punch list item shall be initialed and dated by the Contractor when the work is complete. The Architect/ Engineer will not perform any punch list verification until all items have been completed, initialed, dated and the list returned to the Architect/Engineer. If any items have been initialed as being completed by the Contractor and the Architect/Engineer determines that the work is not complete, the Architect/Engineer shall be reimbursed by the Contractor at his regular hourly rate for any and all items requiring revisiting of the site by the Architect/Engineer. Reimbursement shall be made by deducting the Architect/Engineer fee from the Contractor's final payment.

END OF SECTION 230000

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SECTION 230513 – MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

1.2 SUMMARY

A. This section includes the general requirements for single (1) phase and three (3) phase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 70, “National Electrical Code.”

1. National Recognized Testing Laboratory (NRTL) Listing: Provide NRTL listed motors.

    a. Term “Listed”: As defined in “National Electrical Code,” Article 100.
    b. Listing Agency Qualifications NRTL as defined in OSHA Regulation 1910.7.

2. Comply with NEMA MG 1, “Motors and Generators.”
3. Motors shall be UL listed.

1.4 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

1.5 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Motors shall be designed and selected, for the intended use, in accordance with the scheduled capacities on the drawings and the requirements of this specification.

2.2 MOTOR REQUIREMENTS

A. Compliance: Comply with NEMA MG 1 unless otherwise indicated.

B. Motor Requirements: Requirements below apply to motors covered by this Section except as otherwise indicated.

1. Motors 1 / 2 HP and Larger: Three phase.
2. Motors smaller than 1/2 HP: Single phase.
3. Frequency Rating: 60 Hz.
4. Voltage Rating: Determined by voltage of circuit to which motor is connected for the following motor voltage ratings (utilization voltages):

    a. 120 V Circuit: 115 V - motor rating.
    b. 208 V Circuit: 200 V - motor rating.
    c. 240 V Circuit: 230 V - motor rating.
    d. 480 V Circuit: 460 V - motor rating.

5. Minimum service factor shall be 15% and shall apply at frequency and utilization voltage at which motor is connected. Provide motors which will not operate in service factor range when supply voltage is within 10% of motor voltage rating.
6. Capacity: Sufficient to start and operate connected loads at designated speeds in indicated environment, and with indicated operating sequence, without exceeding nameplate ratings. Provide motors rated for continuous duty at 100% of rated capacity.
7. Temperature Rise: Based on 40ºC ambient except as otherwise indicated.
8. Enclosure: Open drip proof, unless otherwise specified. Provide screen over slots, where slots will permit passage of human extremities.
9. Provide adjustable motor slide base for belt driven equipment. Include adjusting bolts and locknuts.

2.3 MOTOR CHARACTERISTICS

A. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.4 THREE PHASE MOTORS

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

B. Efficiency: Minimum motor efficiencies shall be as follows:

HP	Percent Efficiency, Minimum
1 and less	82.5
1½	84.0
2	84.0
3	87.5
5	87.5
7½	89.5
10	89.5
15	91.0
20	91.0
25	92.4
30	92.4
40	93.0
50	93.0
60	93.6
75 and larger	94.1

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

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

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Motor Frames: Motor frames constructed of aluminum will not be permitted. Motor frame sizes 184T and larger shall be constructed of cast iron. Motor frames sizes smaller than 184T shall be constructed of rolled steel.

2.5 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Motor ratings, characteristics, and features shall be coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.6 SINGLE PHASE MOTORS

A. Motors larger than 1/20 hp shall be one (1) of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Pre lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION

3.1 FIELD INSTALLED MOTORS

A. General: The following requirements apply to field-installed motors.

1. Install motors in accordance with manufacturer's published instructions and the following:

a. Direct Drive Motors: Mount securely in accurate alignment. Connect to driven equipment with coupler of appropriate type and material for the given duty. Coupler shall be selected for high and range of motor application.
b. Belt Drive Motors: Use adjustable motor mounting bases. Align pulleys and install belts. Use belts identified by the manufacturer and tension belts in accordance with manufacturer recommendations.

END OF SECTION 230513

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SECTION 230517 – SLEEVES, SLEEVE SEALS, AND ECUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

1.2 SUMMARY

A. Section includes the requirements for pipe sleeves, sleeve seals and escutcheons for piping systems using the following:

1. Pipe sleeves.
2. Sleeve seal systems.
3. Grout.
4. Escutcheons.
5. Floor plates.

1.3 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, specified options, and warranty information.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sleeves and sleeve seals.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

1.5 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Pipe sleeves, sleeve seals, and escutcheons shall be designed and selected, for the intended use, in accordance with the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Sleeve Seal Systems:
   a. Advance Products & Systems, Inc.
   b. CALPICO, Inc.
   c. Metraflex Company (The).
   d. Pipeline Seal and Insulator, Inc.
   e. Proco Products, Inc.

2.2 PIPE SLEEVES

A. Steel Pipe Sleeves: Steel pipe sleeves shall be standard black steel pipe Type E, Grade B, with plain ends conforming to ASTM A53/A53M.

B. Cast Iron Pipe Sleeves: Cast iron pipe sleeves shall be standard weight cast iron pipe with plain ends conforming to ASTM A74 and CISPI – 301.

2.3 SLEEVE SEAL SYSTEMS

A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.4 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5,000-psi, twenty eight (28) day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 ESCUTCHEONS

A. One (1) Piece, Cast-Brass Type, Deep-Pattern Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.

B. One (1) Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

C. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.

D. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.6 FLOOR PLATES

A. One (1) Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 GENERAL

A. Install all HVAC System sleeves, escutcheons, and associated components as required in accordance with the applicable codes and the best practices of the industry.

B. The work under this section shall be coordinated with that of all trades so that all work may be installed in the most direct and workmanlike manner and so that interference between piping, ducts, equipment, architectural and structural features will be avoided.

C. Coordinate clearance requirements with CM/GC for piping penetrating walls and floor slabs.

D. Mix grout with clean potable water; if grout is to be in contact with stainless-steel surfaces, use demineralized water.

E. Install accessories that do not corrode or soften in either a wet or dry applications.

3.2 PIPE SLEEVE INSTALLATION

A. For Fire-Rated Assemblies (Floors, Walls, Ceilings):

1. Use standard weight steel pipe or service weight cast iron pipe for pipe sleeves. Where sleeves are installed in load bearing walls, use only standard weight steel pipe for pipe sleeves.

2. Provide a minimum of one half (1/2) inch annular space clearance around the entire circumference of the pipe passing through the sleeve.
3. Center pipe passing through sleeve.
4. Do not continue insulation through sleeve.
5. The entire annular space must be sealed with fire stopping sealant.
6. Seal ends of pipe insulation and butt insulation ends up to fire stopping sealant in sleeve.
7. Sleeves in walls must be installed flush with both finished wall surfaces.
8. Sleeves in floors must be installed with top of sleeve one (1) inch above the finished floor surface. The bottom of the sleeve must be flush with the finished surface of the underside of the floor assembly.
9. In finished areas provide an escutcheon plate around the bare pipe or insulated pipe passing through the assemblies to conceal the sleeve and sealant. If a riser clamp is in place, omit the escutcheon.

B. For Non Fire-Rated Assemblies:

1. Floors:

   a. Use standard weight steel pipe or service weight cast iron pipe for pipe sleeves.
   b. Provide a minimum of one half (1/2) inch annular space clearance around the entire circumference of the pipe passing through the sleeve.
   c. Center pipe passing through sleeve.
   d. Do not continue insulation through sleeve.
   e. The entire annular space must be sealed with waterproof sealant.
   f. Seal ends of pipe insulation and butt insulation ends up to waterproof sealant in sleeve.
   g. Sleeves must be installed with top of sleeve one (1) inch above the finished floor surface. The bottom of the sleeve must be flush with the finished surface of the underside of the floor assembly.
   h. In finished areas provide an escutcheon plate around the bare pipe or insulated pipe passing through the assemblies to conceal the sleeve and sealant. If a riser clamp is in place, omit the escutcheon.

2. Walls:

   a. Use standard weight steel pipe or service weight cast iron pipe for pipe sleeves for masonry walls. Where sleeves are installed in load bearing walls, use only standard weight steel pipe for pipe sleeves in masonry walls.
   b. Use standard weight steel or service weight cast iron for pipe sleeve in frame walls.

c. For non-insulated pipes, provide a minimum of one half (1/2) inch annular space clearance around the entire circumference of the pipe passing through the sleeve.
d. For insulated pipes, provide a minimum of one half (1/2) inch annular space clearance around the entire circumference of the insulation.
e. Center insulated pipe passing through sleeve.
f. Continue insulation through sleeve.
g. The entire annular space must be sealed with smoke and acoustic sealant.
h. Sleeves in wall must be installed flush with both finished wall surfaces.
i. In finished areas provide an escutcheon plate around the bare pipe or insulated pipe passing through the assemblies to conceal the sleeve and sealant.

C. Sealant Requirements: Comply with requirements for sealants specified Architectural Specification Section "Joint Sealants".

D. Fire-Barrier Penetrations: Comply with requirements for firestopping specified in Architectural Specification Section "Penetration Firestopping".

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 ECUTCHEONS INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

C. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One (1) piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

END OF SECTION 230517

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SECTION 230519 – METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

1.2 SUMMARY

A. This section includes the requirements for thermometers, and gauges using the following:

1. Vapor actuated thermometers.
2. Liquid-in-glass thermometers.
3. Thermowells.
4. Dial-type pressure gauges.
5. Gauge attachments.
6. Test plugs.

1.3 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, specified options, and warranty information.

1.4 INFORMATIONAL SUBMITTALS

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

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

1.6 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Meters and gauges shall be designed and selected, for the intended use, in accordance with the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide one (1) of the following:

1. Thermometers:
   a. Trerice, H.O. Company.
   b. Weiss Instruments, Inc.
   c. Weksler Instrument Corp.

2. Pressure Gauges:
   a. Trerice, H.O. Company.
   b. Weiss Instruments, Inc.
   c. Weksler Instrument Corp.

3. Test Plugs:
   a. Trerice, H.O. Company.
   b. Flow Design Inc.
   c. Peterson Equipment Company Inc.

2.2 THERMOMETERS

A. General Requirements:

1. Thermometers shall be either vapor actuated or liquid in glass type thermometers suitable for direct or remote mount installation as specified. Provide thermometers were indicated on the drawings and details.

2. Service and Scale Range:

   a. Chilled Water: 0ºF to 100ºF, with two (2) degree scale divisions.

B. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers: Use direct mounted vapor actuated type thermometers as indicated below:

1. Standard: ASME B40.200.
2. Case: Sealed type, cast aluminum or drawn steel four and one half (4-1/2) inch nominal diameter.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Brass, precision geared.
5. Dial: Nonreflective aluminum with permanently etched scale markings graduated in ºF.
6. Pointer: Dark-colored metal.

7. Window: Glass
8. Ring: Metal.
9. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

10. Accuracy: +/-1% of scale range.

C. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers: Use remote mounted vapor actuated type thermometers as indicated below:

1. Standard: ASME B40.200.
2. Case: Sealed type, cast aluminum or drawn steel four and one half (4-1/2) inch nominal diameter with back flange and holes for panel mounting.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Nonreflective aluminum with permanently etched scale markings graduated in ºF.
6. Pointer: Dark-colored metal.
7. Window: Glass.
8. Ring: Metal.
9. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

10. Accuracy: Plus or minus one (1) percent of scale range.

D. Liquid-in-Glass Metal-Case, Industrial-Style Thermometers: Use liquid-in-glass type thermometers as indicated below:

1. Standard: ASME B40.200.
2. Case: Cast aluminum; nine (9) inches nominal size unless otherwise indicated.
3. Case Form: Adjustable angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in ºF.
6. Window: Glass.
7. Stem: Copper-plated steel, aluminum, or brass for a separable and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

8. Accuracy: +/-1% of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Brass or stainless-steel thermometer well.
3. Pressure Rating: Not less than piping system design pressure.
4. Stem length: To extend two (2) inches into fluid or center of pipe, whichever, is shorter.
5. Extension for Insulated Piping: Two (2) inches nominal, but not less than thickness of insulation.
6. Threaded Cap Nut: With chain permanently fastened to well and cap.

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

2.4 PRESSURE GAUGES

A. General Requirements:

1. Provide pressure gauges were indicated on the drawings and as specified.
2. Service and Scale Range in pounds per square inch (PSI):

   a. HVAC Water Systems: Zero (0) to two (2) times operating pressure.
   b. Steam Systems: 0 to 100 psig, with ten (10) figure intervals with 1 psi scale divisions.

3. Standard: ASME B40.100.
4. Case: Liquid-filled type; cast aluminum or drawn steel; four and one half (4-1/2) inch nominal diameter.
5. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
6. Match pressure connection size in first subparagraph below with gauge attachment size.
7. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
8. Movement: Mechanical, with link to pressure element and connection to pointer.
9. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
10. Pointer: Dark-colored metal.
11. Window: Glass.
12. Ring: Metal.
13. Accuracy: Grade A, +/- 1% of scale range.

B. Gage Attachments: Provide gage attachments as indicated below:

1. Syphons: One quarter (1/4) inch straight coil of brass tubing with threads on each end.

2. Gauge Valves: Provide gauge valves (specialty valves) as specified in Division 23 Specification Section "Valves for HVAC Piping Systems".

2.5 TEST PLUGS

A. Description: Nickel plated brass body test plug in one half (1/2) inch fitting.

B. Body: Length as required to extend beyond insulation.

C. Pressure Rating: 500 psig minimum.

D. Core Inserts: Two (2) self-sealing valve types, suitable for inserting a one eighth (1/8) inch (3mm) outside-diameter probe from a dial thermometer or pressure gage.

E. Core Material: According to the following for fluid and temperature range:

1. Air, Water, Glycol Oil, and Gas: 20ºF to 200ºF, neoprene rubber.
2. Air and Water: -30°F to 275°F (-35°C to 136°C), ethylene-propylene-diene-terpolymer (EDPM) rubber.

F. Test Plug Cap: Gasketed and threaded cap, with retention chain.

G. Test Kit: Provide test kit consisting of one (1) pressure gage and gage adapter with probe, two (2) bimetal dial thermometers and a carrying case

H. Pressure Gage and Thermometer Ranges: Approximately two (2) times systems operating conditions.

I. Body: Length as required to extend beyond insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of meters and gauges in the HVAC piping systems. So far as practical, install meters and gauges as indicated.

3.2 THERMOMETERS

A. Install direct-mounted thermometers in thermowells at the most readable position and adjust vertical and tilted positions.

B. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

C. Install thermometers in the following locations:

1. Inlet and outlet of each AHU.

D. For thermometer valves see Division 23 Specification Section “Valves for HVAC Piping Systems”.

3.3 THERMOWELLS

A. Install thermowells with socket extending a minimum of two (2) inches into fluid or center of pipe, whichever is shorter.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

3.4 PRESSURE GAUGES

A. Install pressure gauges in the following locations:

1. Inlet and outlet of each AHU.

B. Install direct-mounted pressure gauges in piping tees with pressure gage located on pipe at the most readable position.

C. Install remote-mounted pressure gauges on panel.

D. For gage valves see Division 23 Specification Section “Valves for HVAC Piping Systems”.

E. Install test plugs in piping tees.

3.5 CONNECTIONS

A. Install thermometers and gauges adjacent to machines and equipment to allow service and maintenance of thermometers, gauges, machines, and equipment.

B. Install gauges adjacent to machines and equipment to allow servicing and maintenance.

3.6 ADJUSTING

A. Adjust faces of thermometers and gauges to proper angle for best visibility.

B. Adjusting: Adjust faces of thermometers and gauges to proper angle for best visibility.

C. Cleaning: Clean windows of thermometers and gauges and factory finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION 230519

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SECTION 230523 – VALVES FOR HVAC PIPING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

1.2 SUMMARY

A. This section includes the requirements for shutoff, drain, specialty, and check valves installed in HVAC piping systems as follows:

1. Hydronic ball valves.
2. Hydronic butterfly valves.
3. Hydronic check valves.
4. Hydronic special valves.

1.3 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, finishes, specified options, and warranty information. Identify valves for each HVAC system application.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

B. In addition to the approved submittals, for each valve type, include the manufacturers printed exploded view type parts and material list indicating how to dismantle, repair and reassemble the valve, and identifying each part.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: The installer shall be a qualified licensed installer within the jurisdiction and familiar with the installation of the valves specified herein for each piping system.

B. Compliance: Comply with the following:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. ProPress Valve Compliance: Valves in propress piping systems shall be in compliance with ASME B31.9 for building service piping valves.

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

1.6 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Information in this article is paraphrased from MSS.

B. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set ball and plug valves open to minimize exposure of functional surfaces.
4. Set butterfly valves closed or slightly open.
5. Block check valves in either closed or open position.

C. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

D. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use hand wheels or stems as lifting or rigging points.

1.8 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Valves shall be designed and selected, for the intended use, in accordance with the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide lead free plumbing valves by one (1) of the following:

1. Ball Valves – Copper and Steel Piping Systems:
   a. Apollo.
   b. Milwaukee.
   c. Watts.
   d. Nibco.
   e. Viega.

2. Butterfly Valves – Copper and Steel Piping Systems:
   a. ABZ.
   b. Milwaukee.
   c. Bray.

3. Check Valves – Copper and Steel Piping Systems:
   a. Apollo.
   b. Milwaukee.
   c. Watts.

4. Special Valves:
   a. Watts.
   b. Spence.
   c. Wilkens.

C. See shut off, drain, & specialty valve application below for required valves.

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

E. Valve Sizes: Same as upstream/downstream piping unless otherwise indicated.

F. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Hand wheel: For valves other than quarter-turn types.
3. Hand lever: For quarter-turn valves NPS 6 and smaller.

G. Valves in Insulated Piping: With two (2) inch stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

2. Butterfly Valves: With extended neck.

H. Valve-End Connections:

1. Threaded Ball Valves: With threads according to ASME B1.20.1.
2. Flanged Butterfly Valves: With flanges according to ASME B16.1 for iron valves.
3. Press End Ball Valves: Where pro press piping systems are used.

I. Provide chain operators in place of valve handles for valves installed in piping systems ten (10) feet or higher above the finished floor of mechanical equipment rooms.

2.2 SHUT OFF, DRAIN, AND SPECIALITY VALVE APPLICATIONS

A. General Application: All Valves installed in HVAC, Steam and Steam Condensate Piping Systems shall be as specified below. For this application, HVAC Piping Systems and Specialty Valves are defined as follows:

1. HVAC Water Piping Systems: Includes Chilled Water, Process Cooling Water, Piping utilizing solder joint, pro press joint and/or flanged joint methods.

2. Drain Valves HVAC Water Flanged, Victaulic and/or Welded Joint Piping Systems Two and One Half (2-1/2) Inch and Larger: Use Two and One Half (2-1/2) Inch, Two (2) Piece Full Port Ball Valves and Trim as indicated below:

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1) Apollo: 77F-140 Series, Brass Body.
2) Milwaukee Valve Company: BA400S Series, Bronze Body.
3) Watts Water Technologies: FVB-3C-SS, Brass Body.
4) Nibco: T585-80-66, Bronze Body.

b. Description:

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) Body Design: Two piece.
4) Body Material: Bronze.
5) Ends: Threaded.
6) Seats: Modified Teflon double seal seats and Teflon seals.
7) Stem: Type 316 Stainless steel.
8) Ball: Type 316 Stainless steel.
9) Port: Full.

10) Handle: Lever Type.
11) Two and One Half (2-1/2) inch capped fire hose connection.

3. Drain Valves for HVAC Water ProPress Piping Systems One Half (1/2) Inch to Two (2) Inch: Use Two (2) Piece Full Port Ball Valves and Trim as indicated below:

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1) Viega: 2970.3, Bronze Body
2) Conbraco Industries, Inc. Apolloxpress 77W-140
3) Milwaukee: BA480S

b. Description:

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) CWP Rating: 600 psig.
4) Body Design: Two (2) piece.
5) Body Material: Bronze.
6) Ends: Press ends, smart connect feature.
7) Seats: EPDM
8) Stem: Type 316 Stainless steel.
9) Ball: Type 316 Stainless steel, vented.
10) Port: Full.
11) Handle: Lever Type.

4. Specialty Valves for HVAC Water Threaded, Flanged, Victaulic, and/or Welded Joint Piping Systems Two and One Half (2-1/2) Inch and Larger: Use One Half (1/2) Inch, Two (2) Piece Full Port Ball Valves and Trim as indicated below:

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1) Apollo: 77F-140.
2) Milwaukee Valve Company: BA400S.
3) Watts Water Technologies: FVB-3C-SS.
4) Nibco: T585-80-66

b. Description:

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) CWP Rating: 600 psig.

4) Body Design: Two piece.
5) Body Material: Bronze or Brass.
6) Ends: Threaded.
7) Seats: Modified Teflon double seal seats and Teflon seals.
8) Stem: Type 316 Stainless steel.
9) Ball: Type 316 Stainless steel, vented.
10) Port: Full.
11) Handle: Lever Type.

5. Shut Off Valves for HVAC Water Flanged, Victaulic, and/or Welded Joint Piping Systems Two and One half (2-1/2) and Larger: Use Bi-directional dead end service high performance butterfly valve as indicated below.

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1) ABZ - 402 – 100 – DDE.
2) Bray Series 41 with trim 466.
3) DeZurik BHPLICS2S5FTTTLT.
4) Milwaukee – HP1LES4211.

b. Description:

1) Standard: MSS SP-68.
2) CWP Rating: 285 psig at 100°F.
3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
4) Body Material: Carbon steel.
5) Seat: modifies Teflon double seal seats and Teflon seals.
6) Stem: Stainless steel; offset from seat plane.
7) Disc: 316 Stainless steel.
8) Service: Bidirectional.
9) For valves used as combination balancing/shut off duty on HVAC systems, provide memory stops.

6. Drain Valves HVAC Threaded, Flanged, Victaulic, and/or Welded Joint Piping Systems Two and One Half (2-1/2) Inch and Larger: Use Two and One Half (2-1/2) Inch, Two (2) Piece Full Port Ball Valves and Stainless Steel Trim as indicated below:

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1) Apollo: 77F-100 (TE), 77-200 (SE).
2) Milwaukee Valve Company: BA-400 (TE), BA-450 (SE).

3) Nibco: T-585-70 (TE), S-585-70 (SE).
4) Watts Water Technologies: FBV-3C (TE), FBVS-3C (SE).

b. Description:

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) Body Design: Two piece.
4) Body Material: Bronze.
5) Ends: Threaded (TE), Soldered (SE).
6) Seats: Modified Teflon double seal seats and Teflon seals.
7) Stem: Brass.
8) Ball: Chrome plated brass.
9) Port: Full.
10) Handle: Lever Type.
11) Two and One Half (2-1/2) inch capped fire hose connection.

2.3 CHECK VALVES

A. Two and One half (2-1/2) inches and smaller use – Bronze Lift Check Valves as indicated below:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Apollo
b. Milwaukee Valve Company.
c. Watts.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

B. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Retain first subparagraph below for optional manual opening feature.

6. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
7. End Connections: Socket, union, threaded, or flanged.
8. Maximum Opening Pressure: 0.50 psig.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 275°F.

C. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

PART 3 - EXECUTION

3.1 GENERAL

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Valves shall be placed in such manner as to be easily accessible for smooth and easy hand wheel operation and packing maintenance.

B. Install valves in piping where shown and where listed herein:

1. To balance flows in water piping systems.
2. To isolate all items of equipment.
3. To isolate motorized flow control valves.
4. To isolate branch lines and risers at mains.
5. To drain low points in piping systems.
6. To drain pipe risers.
7. To drain equipment.

8. To drain trapped sections in the piping system.

C. Where piping or equipment may be subsequently remove, provide valves with bodies having integral flanges or full lugs drilled and tapped to hold valve in place so that downstream piping or equipment can be disconnected and replaced with blank-off plate while valve is still in service.

D. Valves for equipment and controls shall be installed full size of pipe before reducing size to make equipment connection.

E. Where there is no interference, shut-off valves shall be installed with handwheel up on horizontal runs of pipe to prevent accumulation of foreign matter in working parts of valves. In no case shall the stem be installed below the pipe centerline.

F. On valves, strainers, etc., installed in copper piping, provide a union on the discharge side of each valve and threaded adapters where copper piping connects to valves, strainers, etc.

G. Drawings indicate the general arrangement of piping, fittings, and specialties.

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

I. Install valves in a position to allow full handle movement.

J. Install safety relief valves on hot water generators, boilers, pressure vessels, etc. and elsewhere as required by ASME Boiler and Pressure Vessel Code. Pipe discharge without valves as shown on drawings, or to nearest floor drain if not shown on drawings. Comply with ASME Boiler and Pressure Vessel Code Section VIII, Division 1 for installation, requirements.

K. Install shut-off valves upstream and downstream of each pressure regulator.

L. Where threaded ball valves are installed in brazed copper piping systems braze each threaded adapter on to the piping. After each adapter has cooled to the touch install the threaded ball valve. Do not connect the threaded adapter to the valve and then braze the adapter and valve to the piping as this will result in damage to the valve seals. If any valve, in the brazed piping systems are damaged due to faulty installation the damaged valves shall be replaced by the contractor at no cost to the University.

M. Where butterfly valves are installed in copper piping systems provide companion flanges and dielectric gasket kits for each flange. When valves and/or fittings are installed in piping where electrolysis may occur provide dielectric unions at each connection.

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

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

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

Q. Install chain wheels on operators for ball and butterfly valves four (4) inches and larger and more than ten (10) feet above floor. Extend chains to sixty (60) inches above finished floor. This requirement is limited to mechanical equipment rooms only.

R. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Lift Check Valves: With stem upright and plumb.

3.3 SPECIAL VALVE APPLICATIONS

A. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal and AHU coil.

3.4 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.5 THREADED CONNECTIONS

A. Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.

B. Align threads at point of assembly.

C. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.

D. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

3.6 FLANGED CONNECTIONS

A. Align flange surfaces parallel.

B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

C. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

END OF SECTION 220523

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SECTION 230529 – HANGERS AND SUPPORTS FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

1.2 SUMMARY

A. This section includes the requirements for hangers and supports for HVAC piping and equipment as follows:

1. Metal pipe angers and supports.
2. Trapeze pipe hangers.
3. Thermal hanger shield inserts.
4. Fastener systems.
5. Pipe stands.
6. Pipe positioning system.
7. Miscellaneous materials.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.
4. Support for all conditions of operation, including variations in installed and operating weight of equipment, piping and ductwork, to prevent excess stress and allow for proper expansion and contraction.

C. Support materials shall be steel or stainless steel unless specifically indicated.

D. Support devices shall be factory fabricated by manufacturers and have published load ratings.

E. Unless otherwise indicated, design structural support members and support devices, including couplings, rods, trapeze supports and strut systems, with safety factor in accordance with AISC Manual of Steel Construction, but not less than 2.0.

F. Unless otherwise indicated, hangers, support devices and hardware shall be steel and shall have factory standard black, primed, galvanized or electroplated finish for indoor application, and hot-dipped galvanized finish for outdoor application and corrosive atmospheres. Coat cut edges, welds or any damaged finish with galvanized paint.

G. Material in contact with pipe shall be compatible with piping material so that neither shall have deteriorating action on the other. If materials such as copper, stainless steel or other materials are not compatible, provide nonmetallic separation between uninsulated piping and metal supports. Plastic coated steel supports are acceptable.

H. Unless otherwise indicated, steel support devices exposed to ventilation air stream shall be stainless steel or steel with either galvanized finish or paint finish.

I. Fiberglass piping system supports shall meet the more stringent of (a) the requirements of these specifications and (b) the piping manufacturer's recommendations.

J. Contractor is responsible for proper placement and sizing of supporting devices to accommodate insulation thickness and pitching of pipe. Coordinate with Contractor performing work specified in Section "Insulation for HVAC Pipe and Duct Systems".

K. Where piping can be conveniently grouped to allow trapeze type supports, supporting steel shall be by means of standard structural shapes.

L. Hangers and rods shall be plumb when pipelines are at their normal operating temperatures.

M. Unless otherwise indicated, continuous insert channels are not allowed.

N. Punching, drilling, or welding of building structural steel is not allowed unless approved by Structural Engineer.

O. Application of concrete inserts and concrete anchors shall be reviewed and approved by Structural Engineer prior to installation.

P. Lateral bracing for piping and equipment shall be reviewed and approved by Structural Engineer prior to installation. Lateral braces shall be designed and detailed to apply loads as directly as possible to structural floor slabs, roof decks, or other building lateral

elements. Braces shall not be applied to bottom flanges of steel beams or bottom chords of steel joists.

Q. Any proposed weld attachments to building structure shall be reviewed by Structural Engineer prior to execution of work. This review may result in use of other welding codes or standards, which may apply to "structural work". Execution of this work may be assigned to General Trades responsible for building structural steel. Cost for this work, however, will remain the responsibility of this Contractor.

R. Fasteners including concrete anchors for seismic application shall have ICC Evaluation Service Report (ESR) and meet requirements of local authorities.

1.4 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, wirings diagrams, power requirements, specified options, and warranty information.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

1.7 QUALITY ASSURANCE

A. Materials and application of pipe hangers and supports shall conform to latest requirements of ANSI/ASME B31 Code for Pressure Piping and MSS Standard Practice SP-58 (Materials, design and Manufacture), SP-69 (Selection and Application), and SP-89 (Fabrication and Installation Practices), except as supplemented or modified herein.

B. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.8 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Design and Selection: Hangers and supports shall be designed and selected, for the intended use, in accordance with the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide comparable product by one (1) of the following:

1. Metal Pipe Hangers and Supports:
   a. B-Line.
   b. Fee and Mason.
   c. Anvil.
   d. Michigan Hanger.

2. Thermal-Hanger Shield Inserts (Pre-Insulated Pipe Supports):
   a. Pipe Shields, Inc. (Piping technology & Products, Inc.)
   b. Bergen Pre-Insulated Pipe Supports
   c. Rilco.

3. Thermal-Hanger Shield Inserts:
   a. Pipe Shields, Inc. (Piping technology & Products, Inc.)
   b. Bergen Pre-Insulated Pipe Supports
   c. Rilco.

4. Fastener Systems (Concrete Anchors):
   a. Hilti,
   b. Powers Fasteners or
   c. Red Head

5. Metal Framing Support System:
   a. Unistrut,
   b. B-Line Strut Systems
   c. Anvil-Strut
   d. Kindorf
   e. Hilti

6. Pipe Guides and Anchors:
   a. Shaw Pipe Shields
   b. Bergen Pre-Insulated Pipe Supports
   c. Rilco

7. Pipe and Equipment Supports - Roof Level:
   a. Pate Company.

b. Roof Products and Systems (RPS).
c. Tybar Corporation.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Insulated Horizontal Piping Hangers: Chilled Water (fluid temperature at or below 100 ºF):

1. Two (2) inch and smaller: Figure No. B3108 with metal shield, Figure No. B3151.
2. Two and one-half (2-1/2) inch and larger: Figure No. B3108 with metal shield, Figure No. B3151.

B. Insulated and non-insulated vertical piping hangers:

1. Figure No B3373

C. Insulated and non-insulated vertical piping hangers:

1. Hangers Copper: B3373F.

2.3 TRAPEZE PIPE AND EQUIPMENT HANGERS

A. Description: Direct mounting hangers:

1. Anvil Figure No. 46.
2. Piping: Use straps, slides or rollers as specified below for Flat Surface (Trapeze, Rack Type) support system.
3. Suspended Equipment: Contractor shall support suspended equipment with any combination of trapeze supports, or miscellaneous steel angles or channels properly sized for the weight and hung from the structure with spring isolation hangers.

2.4 FLAT SURFACES (TRAPEZE, RACK TYPE)

A. Description: Use structural steel members such as struts, angles, channels and beams to support pipes as required. Select members properly for pipe support types and loading conditions. Submit support details with type of members selected and load calculations. Provide straps, clamps, rollers or slides indicated below at each support point.

B. Non - Insulated Horizontal Piping:

1. Six (6) inch and smaller (steel): Vibra-Clamp, B-Line, Figure No. BVT.
2. Eight (8) inch and larger (steel): U-Bolt, B-Line, Figure No. B3188.
3. All sizes (copper): Vibra-Clamp, B-Line, Figure No. BVT.

C. Insulated Horizontal Piping: Chilled Water (fluid temperature at or below 100 ºF):

1. Eight (8) inch and smaller: U-Bolt, B-Line, Figure No. B3188.
2. Ten (10) inch and larger: Roller, B-Line Figure No. B3120, B3122, B3122A, B3117SL.

2.5 INSULATION PROTECTION SHIELDS

A. B-Line Figure No. 3151 constructed of galvanized carbon steel. Per the latest edition of Standard MSS SP-58, select shield to accommodate outer diameter of insulation. Shield length and gauge for insulation compression strength not less than 15 psi.

B. Minimum 18 gauge thick and 12" long for piping up to 4", 16 gauge thick and 18" long for piping 5" through 6", 14 gauge thick and 24" long for piping 8" through 14" and 12 gauge thick and 24" long for piping 16" and larger.

C. Shields and saddles for fiberglass piping shall be provided as recommended by the piping system manufacturer.

2.6 INSULATION PROTECTION SADDLES

A. B-Line Figure No. 3160 through 3165 constructed of carbon steel or alloy steel plate. Select saddles to accommodate insulation thickness specified.

2.7 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend two (2) inches beyond sheet metal shield for piping operating below ambient air temperature.

2.8 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.9 PIPE STANDS

A. For support of pipe where axial movement is encountered: Figure No. B33117Sl where no vertical adjustments is required; and Figure B3118SL where vertical adjustments is required.

B. Compact Pipe Stand: One (1) piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe.

C. Low-Type, Single-Pipe Stand: One (1) piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Stainless steel.
3. Vertical Members: Two (2) or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports.
2. Bases: One or more; plastic.
3. Vertical Members: Two (2) or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

2.10 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.11 FABRICATED EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

B. Delegated Design: Calculate requirements for support of equipment weight and restraint of both lateral and vertical dynamic forces at 150% of operating conditions.

C. Details: Detail fabrication of each support assembly. Show dimensions and methods of assembly and attachment to building structure.

2.12 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5,000-psi, (34.5-MPa)(34.5-MPa)(34.5- MPa), twenty eight (28) day compressive strength.
3. Water: Potable
4. Packaging: Premixed and factory-packaged.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Vertical Piping Riser Clamps:

1. Copper Pipe: Figure No. B3373CT.
2. Steel Pipe: Figure No. B3136 and B3137.

E. Beam Clamps and Attachments:

1. For bolt-on locations to structure, Figure Nos. B3291, B3036, B3050.
2. Welded beam attachments, Figure No. B3083.

F. Concrete Inserts:

1. For concrete spot inserts at single locations for casting into structure, Figure No. B3014 for pre- determined rod size and Figure No. B2500 for universal use.
2. For continuous slot concrete insert at multi-locations for casting into structure, Figure No. B2505.

G. Brackets:

1. For equipment and piping adjacent to walls or steel columns, Figure Nos. B3066, B3063 and B3067 depending on weight to be supported.

H. Pipe Rests:

1. For pipes close to floor where no expansion provision is required, Figure No. B3088T base stand with B3093 adjustable pipe saddles support.

I. Hanger Rods:

1. Hanger rod, Figure No. B3205.
2. Continuous threaded rod, Figure No. ATR.
3. Eye rods, Figure No. B3210 or B3211, depending on load supported.

J. Spring Hangers:

1. Light loads, movement less than one and one quarter (1-1/4) inches, Figure No. B3262 or B3264.

K. Protection Saddles:

1. Cast iron pipe, insulated, Figure No. B3108 with metal shield, Figure No. B3151.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Install supports to allow for free expansion of piping. Support piping from building structural members using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. At no time shall hangers and supports overload building structural members. Fasten ceiling plates and wall brackets securely to structure and test to demonstrate adequacy of fastening.

B. Select and size building attachments properly in accordance with MSS Standards and manufacturer's published load rating information.

C. Coordinate hanger and support installation to properly group piping of all trades.

D. Suspend hangers by means of hanger rods. Perforated band iron and flat wire (strap iron) are not allowed.

E. Piping and ductwork shall be supported independently from other piping or ductwork.

F. Pipe hangers and supports shall not penetrate vapor barrier of pipe insulation.

G. Do not support equipment, piping or ductwork from metal roof decking or ceiling grid.

H. Install adequate supports so as not to over stress either piping or equipment to which piping is connected.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly supported piping from the building structure.

1. Horizontal Piping: Support horizontal piping within twelve (12) inches of each fitting and coupling.
2. Base of Vertical Piping: Provide MSS Type 52, spring hangers.
3. Vertical Pipe Supports: Install supports for vertical steel pipe and copper tubing at each floor level.
4. Individual, Straight, Horizontal Piping Runs:

a. One hundred (100) Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
b. Longer than One Hundred (100) Feet: MSS Type 43, adjustable, roller hangers.
c. Longer than One hundred (100) Feet if Indicated: MSS Type 49, spring cushion rolls.
d. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
e. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
f. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
3. Multiple, Straight, Horizontal Piping Runs One hundred (100) Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

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

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than four (4) inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

G. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

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

I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

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

L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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

N. Upper attachments to structures shall have an allowable load not exceeding one quarter (1/4) of the failure (proof test) load but are not limited to the specific methods indicated.

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

P. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

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

   a. NPS 1/4 to NPS 3-1/2: Twelve (12) inches long and 0.048 inch thick.
   b. NPS 4: Twelve (12) inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: Eighteen (18) inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: Twenty four (24) inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: Twenty four (24) inches long and 0.105 inch thick.

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

Q. Conform to the table below for maximum spacing of supports and rod sizes:

1. Steel and Copper Pipe:

Nom. Pipe Size - In.	Steel Pipe Max. Span - Ft. (In.)	Copper Tube Max. Span - Ft. (In.)	Min. Rod Dia. – In.

Up to 3/4	7 (84)	5 (60)	3/8
1	7 (84)	6 (72)	3/8
1-1/4	7 (84)	7 (84)	3/8
1-1/2	9 (108)	8 (96)	3/8
2	10 (120)	8 (96)	3/8
2-1/2	11 (132)	9 (108)	1/2
3	12 (144)	10 (120)	1/2
3-1/2	13 (156)	11 (132)	1/2
4	14 (168)	12 (144)	5/8 (1/2 for copper)
5	16 (192)	13 (156)	5/8 (1/2 for copper)
6	17 (204)	14 (168)	3/4 (5/8 for copper)
8	19 (228)	16 (192)	7/8 (3/4 for copper)
10	22 (264)	18 (216)	7/8 (3/4 for copper)
12	23 (276)	19 (228)	7/8 (3/4 for copper)

a. Support vertical steel pipe and copper tube at each floor level.
b. Rod diameter may be reduced one (1) size for double-rod hangers, with three eights (3/8) inch minimum rods.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to one and one half (1-1/2) inches.

3.5 PAINTING

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

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

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Architectural Specification Sections "Exterior Painting" and/or Section "Interior Painting."

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 230529

SECTION 230533 – HEAT TRACING FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

1.2 SUMMARY

A. This section includes the requirements for heat tracing HVAC piping for freeze prevention, with the following electric heating cables:

1. Self-regulating, parallel resistance.

1.3 ACTION SUBMITTALS

A. Product Data: For each product specified, include manufacturers cut sheets, dimensional data, performance data, installation instructions, wirings diagrams, power requirements, specified options, and warranty information.

B. Shop Drawings: For electric heating cable include:

1. Heat tracing system shop drawings shall include elevations, sections, and attachment details. Include diagrams for power, signal, and control wiring.
2. Scheduled information shall include heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
3. Engineering data sheets for manufactured materials shall include dimensions, rated capacities, operating characteristics, and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of the final approved submittal for each product in the operation and maintenance manuals.

1.6 WARRANTY/GUARANTEE

A. See Division 23 Specification Section "Basic Mechanical Requirements – HVAC" for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Heat tracing equipment and specialties shall be designed and selected, for the intended use, in accordance with the scheduled capacities on the drawings and the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Heat Trace System and Accessories:

a. Brisk Heat.
b. Chromalox.
c. Delta-Therm Corporation.
d. Easy Heat; a division of EGS Electrical Group LLC.
e. Nelson Heat Trace; a division of EGS Electrical Group LLC.
f. Pyrotenax; a brand of Tyco Thermal Controls LLC.
g. Raychem; a brand of Tyco Thermal Controls LLC.
h. Thermon Americas Inc.

2.2 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Comply with IEEE 515.1.

B. Heating Element: Pair of parallel No. 16 AWG, tinned, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

C. Electrical Insulating Jacket: Flame-retardant polyolefin.

D. Outer jacket in "Cable Cover" Paragraph below is optional feature and is required for waterproof applications; verify availability with manufacturer.

E. Cable Cover: Tinned-copper braid and polyolefin outer jacket with ultraviolet inhibitor.

F. Maximum Operating Temperature (Power On): 150°F.

G. Verify temperature of circulated media in freeze-protected piping in "Maximum Exposure Temperature (Power Off)" Paragraph below.

H. Maximum Exposure Temperature (Power Off): 185°F.

I. 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.

J. Capacities and Characteristics:

1. Maximum Heat Output: Five (5) Watts/ft.
2. Electrical Characteristics for Single-Circuit Connection:

a. Volts: One hundred twenty (120)
b. Phase: Single (1) phase
c. Hertz: Sixty (60)

2.3 CONTROLS

A. Pipe-Mounted Thermostats for Freeze Protection:

1. Remote bulb unit with adjustable temperature range from 30°F to 50°F.
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
4. Corrosion-resistant, waterproof control enclosure.

B. Precipitation and Temperature Sensor for Snow Melting on Roofs and in Gutters:

1. Microprocessor-based control with manual on, automatic, and standby/reset switch.
2. Precipitation and temperature sensors shall sense the surface conditions of roof and gutters and shall be programmed to energize the cable as follows:

a. Temperature Span: 34°F to 44°F.
b. Adjustable Delay-Off Span: Zero (0) to ninety (90) minutes.
c. Energize Cables: Following two (2) minute delay if ambient temperature is below set point and precipitation is detected.
d. De-Energize Cables: On detection of a dry surface plus time delay.

3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.
4. Minimum Thirty (30)-A contactor to energize cable or close other contactors.
5. Freestanding sensor can be used for snow and ice melting on roofs and in gutters.
6. Precipitation sensor shall be freestanding.
7. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control-system workstation.

2.4 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Division 23 Specification Section "Identification for HVAC Systems and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than six (6) Inches: Three quarter (3/4) inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, six (6) Inches or Larger: One and one half (1-1/2) inches minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

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

3.2 APPLICATIONS

A. Install the following types of electric heating cable for the applications described:

1. Self-regulating, parallel-resistance heating cable.

3.3 INSTALLATION

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating-Cable Installation for Freeze Protection for Piping:

1. Install electric heating cables after piping has been tested and before insulation is installed.
2. Install electric heating cables according to IEEE 515.1.

3. Install insulation over piping with electric cables according to Division 23 Specification Section "Insulation for HVAC Pipe and Duct Systems."
4. Install warning tape on piping insulation where piping is equipped with electric heating cables.

C. Set field-adjustable switches and circuit-breaker trip ranges.

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Specification Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Specification Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

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

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage during construction.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION 230533

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SECTION 230553 – IDENTIFICATION FOR HVAC SYSTEMS AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

1.2 SUMMARY

A. This section includes the requirements for identification of HVAC piping and equipment using the following:

1. Equipment labels.
2. Warning signs.
3. HVAC pipe system labels.
4. HVAC duct system stencils.
5. Valve tags.
6. Ceiling markers.
7. Engraved signs.
8. Warning tags
9. Underground pipe markers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Samples: For color, letter style, and graphic representation required for each identification material and device.
2. Data: Installation details, material descriptions, dimensions of individual components for each type tag and sign.
3. Equipment Label Schedule: Submit a sample equipment label schedule for each fire protection system. Include a list of all equipment to be labeled, the proposed content for each label and the location in an “xl” file format.
4. Valve Numbering Schedule: Submit a sample valve tag schedule for each fire protection system. Include equipment tag designation, name and location in an “xl” file format.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of the final approved submittal for each product in the operation and maintenance manuals.

B. Valve Schedules: Include a valve schedule for each piping system in the operation and maintenance manual. The valve schedule shall be an electronic file in “doc” format and

printed as a "pdf" file for insertion in the O & M manual. Submit the "doc" file separate from the O & M electronic file.

1.5 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Names, Abbreviations and Designations: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

1.6 WARRANTY/GUARANTEE

A. See Division 23, Specification Section "Basic Mechanical Requirements – HVAC" for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Labels, Signs and Tags: All labels, signs and tags shall conform to ANSI/OSHA requirements for letter/color combinations.

B. Basis of Design: The basis of design shall be mechanical identifications materials manufactured by the Seton Name Plate Corporation as follows:

1. Equipment Labels – Style M4562 – M4565
2. Warning Signs – Style M4562 – M4565
3. HVAC Pipe Labels – Size 8SM - 32
4. Duct System Labels – Custom Stencils
5. Valve Tags – Style 374

C. Other Acceptable Manufacturers: Subject to compliance with requirements, provide mechanical identifications materials from one (1) of the following:

1. Brady (Wilt.) Co. Singmark Division.
2. Industrial Safety Supply Co., Inc.

2.2 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, one eighth (1/8) inch thick, and having predrilled holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than two and one half (2-1/2) inch by three quarter (3/4) inch.
3. Minimum Letter Size: One quarter (1/4) inch for name of units if viewing distance is less than twenty four (24) inches, one half (1/2) inch for viewing distances up to seventy two (72) inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two thirds (2/3) to three fourths (3/4) the size of principal lettering.
4. Fasteners: Self tapping stainless steel screws, screws, except contact type permanent adhesive where screws cannot or should not penetrate the substrate.
5. Adhesive: Contact type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's label as indicated on the construction documents.

C. Equipment Label Schedule:

2.3 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, one eighth (1/8) inch thick, and having predrilled holes for attachment hardware.

B. Minimum Label Size: Length and width vary for required label content, but not less than two and one half (2-1/2) inch by three quarter (3/4) inch.

C. Minimum Letter Size: One quarter (1/4) inch for name of units if viewing distance is less than twenty four (24) inches, one half (1/2) inch for viewing distances up to seventy two (72) inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two thirds (2/3) to three quarters (3/4) the size of principal lettering.

D. Fasteners: Stainless steel self tapping screws.

E. Adhesive: Contact type permanent adhesive, compatible with label and with substrate.

F. Label Content: Include caution and warning information plus emergency notification instructions.

2.4 HVAC PIPE SYSTEMS LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

1. Do not use pipe labels or plastic tapes for bare pipes conveying fluids at temperatures of 125°F (52°C) or higher

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover or cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

1. Small Pipes: For external diameters less than six (6) inches (including insulation if any, provide full band pipe markers, extending 360 degrees around pipe at each location, fastened by one (1) of the following methods:

a. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
b. Adhesive lap joint in pipe marker overlap.
c. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than three quarter (3/4) inch wide; full circle at both ends of pipe marker, tape lapped one and one half (1-1/2) inches.

2. Large Pipes: For external diameters of six (6) inches and larger (including insulation if any), provide either full band or strip type pipe markers, but not narrower than three (3) times letter height (and of required length), strapped to pipe (or insulation) application of semi rigid type, with manufacturer's standard nylon ties.

a. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than one and one half (1-1/2) inches wide; full circle at both ends of pipe marker, tape lapped three (3) inches.
b. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Pipe label contents shall comply with the following:

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least one and one half (1-1/2) inches high.
3. Label Designation and Colors: See chart on the next page.

HVAC SERVICE DESIGNATION	LABEL DISIGNATION	FIELD/LETTER COLOR
Primary Chilled Water Supply	Same as Service Designation	Yellow / Black
Primary Chilled Water Return	Same as Service Designation	Yellow / Black
Process Cooling Water Supply	Same as Service Designation	Yellow / Black
Process Cooling Water Return	Same as Service Designation	Yellow / Black

AC Condensate Drain	Same as Service Designation	Yellow / Black

2.5 HVAC DUCT SYSTEM STENCILS

A. Custom Stencils for Duct Systems:

1. Stencil Material: Brown Oil Board
2. Lettering Size: Minimum letter height of three (3) inches. Stencil designations can be one (1) or two (2) lines.
3. Number of Characters: The number of characters may be up to fifty (50) depending on the specified designation.
4. Stencil Paint: Exterior, gloss, black acrylic enamel. Paint may be in pressurized spray can form.
5. Directional Arrows: Include directional arrows.

B. Stencils for Access Panels and Door Labels

1. Lettering Size: Minimum letter height of one half (1/2) inch for viewing distances up to seventy two (72) inches and proportionately larger lettering for greater viewing distances.
2. Stencil Paint: Exterior, gloss, acrylic enamel. Paint may be in pressurized spray can form.
3. Identification Paint: Exterior, acrylic enamel. Paint may be in pressurized spray can form.

C. Duct Stencil Markers: Provide duct stencil markers with the following designations and letter color:

SERVICE	STENCIL DISIGNATION	LETTER COLOR
Main Supply Air Duct	Main Supply Air Duct – AHU – #	Black
General Exhaust Air Duct	General Exhaust Air Duct – GEF – #	Black
Supply Air Duct	Supply Air Duct – STU – #	Black
Exhaust Air Duct	Exhaust Air Duct – ETU – #	Black
Outside Air	Out Side Air – AHU – #	Black
Relief Air	Relief Air – AHU – #	Black
Access Door - Supply	ADS – Positive Pressure	Black
Access Door - Exhaust	ADE – Negative Pressure	Black

2.6 VALVE TAGS AND SCHEDULE

A. General: Valve tags and schedule are required to identify what systems the valves are installed in, where the valves are located and what duty the valves perform. Valve duty usually includes the following:

1. Shut off duty for rooms, equipment, control valves and/or floors.
2. Combination balancing/shut off duty.
3. Riser isolation duty.
4. Drain valves.
5. Control valves.
6. Shut off duty for back flow preventer.

B. Valve Tags:

1. Description: Stamped or engraved with one quarter (1/4) inch letters for piping system abbreviation and one half (1/2) inch numbers

   a. Brass Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   b. Fasteners: Brass wire-link chain

2. Plastic Laminate Valve Tags: Provide manufacturer's standard three thirty second (3/32) inch thick engraved plastic laminate valve tags, with piping system abbreviation in one quarter (1/4) inch high letters and sequenced valve numbers one half (1/2) inch high, and with five thirty second (5/32) inch hole for fastener.

   a. Provide One and one half (1-1/2) inch sq. black tags with white lettering, except as otherwise indicated.
   b. Provide size, shape and color combination as specified or scheduled for each piping system.

3. Plastic Valve Tags: Provide manufacturer's standard solid plastic valve tags with printed enamel lettering, with piping system abbreviation in approximately three sixteenth (3/16) inch high letters and sequenced valve numbers approximately three eights (3/8) inches high, and with five thirty second (5/32) inch hole for fastener.

   a. Provide one and one eighth (1-1/8) inch sq. white tags with black lettering.
   b. Provide size, shape and color combination as specified or scheduled for each piping system.
   c. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for

proper attachment of tags to valves, and manufactured specifically for that purpose.

4. Valve Tag Data: See chart below:

HVAC VALVE SERVICE	VALVE TAG DISIGNATION
Chilled Water Supply	CHS – #
Chilled Water Return	CHR-#
Process Chilled Water Supply	PWS-#
Process Chilled Water Return	PWR-#

C. Valve Schedules: Provide a valve schedule in an "xl" file format for each HVAC piping system. File shall include the valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room, space, equipment, pipe riser), and valve duty. Also mark valves for emergency shutoff and similar special uses as required by the project.

1. Numbering System: Valves shall be in numerical order starting with one (1) for each HVAC system.

2. BAS Control Valves: BAS control valves shall be numbered in numerical order for each HVAC system utilizing the "control valve number from the BAS submittal.

2.7 CEILING MARKERS

A. Ceiling Grid and Access Panel Markers: Provide Kroy type clear adhesive printed labels with three sixteenth (3/16) inch high letters to identify the type of concealed equipment, valves, volume dampers, reheat coils, control dampers, etc.

B. Ceiling Marker Data: For HVAC the printed data shall be as follows:

ITEM	SERVICE	LABEL
LP Drain	Low Point Drain	HVAC – LPD – **
Air Vent	Manual Air Vent	HVAC – MAV
STU	Supply Terminal Unit	HVAC – STU
GETU	General Exhaust Terminal Unit	HVAC – GETU
DFDAD	Duct Fire Damper Access Door	HVAC – DFDAD
DFSDAD	Duct Fire/Smoke Damper Access Door	HVAC – DFSDAD

** System ID: Chilled Water (CHW)

2.8 ENGRAVED PLASTIC LAMINATE SIGNS

A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: One eighth (1/8) inch, except as otherwise indicated.

C. Fasteners: Self tapping stainless steel screws, except contact type permanent adhesive where screws cannot or should not penetrate the substrate.

D. Nomenclature: Include the following, matching terminology on schedules as closely as possible.

E. Size: Provide approximate two and one half (2-1/2) inch x four (4) inch markers for control devices, dampers, and valves; and four and one half (4-1/2) inch x six (6) inches for equipment.

2.9 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Three (3) inches by five and one quarter (5-1/4) inches minimum.
2. Fasteners: Self tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

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

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Piping Color Coding: Per schedule.

B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of fifty (50) feet along each run. Reduce intervals to twenty five (25) feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

3.5 DUCT LABEL INSTALLATION

A. Stenciled Duct Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.

B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of fifty (50) feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6 VALVE TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory fabricated equipment units, shutoff valves, faucets, convenience

connections, and HVAC terminal devices and similar roughing in connections of end use fixtures and units. List tagged valves in a valve schedule.

3.7 WARNING TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.8 VALVE TAG SCHEDULE

A. Include the valve schedule file in the electronic operation and maintenance manual.

3.9 CEILING MARKERS

A. Location: Install each ceiling marker label on the surface of the ceiling grid 'T' bar and/or on the frame of an access door.

3.10 ADJUSTING AND CLEANING

A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.

B. Cleaning: Clean face of identification devices.

END OF SECTION 230553

SECTION 230593 – TESTING, ADJUSTING, AND BALANCING HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

1.2 SUMMARY

A. This section includes the requirements for testing, adjusting and balancing the following systems:

1. Balancing Air Systems:

    a. Supply air distribution systems.
    b. Exhaust air distribution systems.
    c. Supply and exhaust air devices.

2. Balancing Hydronic Piping Systems:

    a. Secondary hydronic systems.

3. Testing, Adjusting, and Balancing Equipment:

    a. Air handling units.
    b. Heat transfer coils.
    c. Fan coil units, cabinet heaters, unit heaters.
    d. Exhaust/Relief/Return air fans.

1.3 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of fourteen (14) days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

    a. The Contract Documents examination report.
    b. The TAB plan.
    c. Needs for coordination and cooperation of trades and subcontractors.
    d. Proposed procedures for documentation and communication flow

1.4 ACTION SUBMITTALS

A. Agency Data: within thirty (30) days of award of contract submit proof that proposed testing, adjusting, and balancing agency meets the qualifications specified.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within thirty (30) days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within ninety (90) days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within sixty (60) days of Contractor's Notice to Proceed, submit TAB strategies and step by step procedures as specified in "Preparation" Article.

D. System Readiness Checklists: Within ninety (90) days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Final TAB Report Submittal: Within thirty (30) days after all fieldwork has been completed, submit a final TAB report as detailed in Part 3 of this Section to assure design objectives are met and to assist Owner in future maintenance.

1.6 CLOSEOUT SUBMITTAL

A. Operation and Maintenance Data: Include a copy of the final approved TAB Report in the operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. General: Employ services of an independent testing, adjusting, and balancing agency to be the single source of responsibility to test, adjust, and balance the HVAC systems indicated on the drawings serving the project area. Services shall include checking installations for conformity to design, measurement and establishment of fluid quantities of mechanical systems as required to meet the requirements of the design documents, and record and report the results.

B. Certification: Certified by Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project, and having at least one (1) Professional Engineer registered in State in which services are to be performed, certified by AABC as Test and Balance Engineer. NEBB certified balancing companies will not be permitted.

C. TAB Specialists Qualifications: Certified by AABC.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

G. Work shall be accomplished in accordance with specifications. Procedures specified shall be followed and, if not specifically described herein, in general, shall be in accordance with Associated Air Balance Council's National Standards.

H. Design Review: Review all design drawings and specifications.

1. Review shall include:

a. Duct pressure classification.
b. Control device location and balancing devices location in duct systems and piping systems.
c. Indicate additional balancing devices required for proper balancing.
d. Specifications on all devices required for balancing.
e. Note any potential noise problems.

2. Within ninety (90) days of award of contract, meet with the CM, Owner, A/E, Mechanical Contractor, and Building Automation System Contractor to review procedures and agenda and comments on design documents as to potential problem areas.

I. Shop Drawing Review: Review the Building Automation System (BAS) shop drawing submittals noting any potential balancing problems. Note comments on submittal, sign, stamp and return to General Contractor. All BAS submittals must be reviewed by balancing agency prior to review by the engineer.

J. Pre Balancing Conference: Prior to beginning of testing, adjusting, and balancing procedures, schedule and conduct conference with the CM, Owner, and representatives of installers of mechanical systems. Objective of conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

K. During construction, balancing agency shall inspect the installation of pipe systems, sheet metal work, temperature controls, and other component parts of heating, ventilating, and

air conditioning systems. Inspections shall be performed periodically as work progresses. Minimum of two (2) inspections are required as follows:

1. One (1) when 60% of ductwork is installed;
2. Two (2) when 90% of equipment is installed.
3. Balancing agency shall submit brief written report of each inspection to Owner and engineer.

1.8 STANDARDS

A. Associated Air Balance Council (AABC) Publication: National Standards for Testing and Balancing Heating, Ventilating and Air Conditioning Systems, Latest Edition.

B. American Society of Heating, Refrigeration and air Conditioning Engineers (ASHRAE) Publications:

1. "ASHRAE Research Report No. 1162, "Air Flow Measurements at Intake and Discharge Openings and Grilles," ASHVE Transactions, Volume 46.
2. ASHRAE Handbook of Fundamentals, Latest Edition.

C. American National Standards Institute (ANSI) Publications:

1. ANSI/AIHA Z9.5 American National Standard for Laboratory Ventilation, Latest Edition.
2. S1.4 General - Purpose Sound Level Meters, Specifications for,

D. Sheet Metal and Air Conditioning Contractors National Association Inc. (SMACNA) - Air Duct Leakage Test Manual, Latest Edition.

1.9 FIELD CONDITIONS

A. New Construction Project: University personnel will occupy the new building beginning from the projects date of substantial completion. All TAB operations shall be completed prior to the date of substantial completion.

1.10 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. Provide all required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements shall be in accordance with requirements of AABC.

B. Instruments used for measurements shall be accurate, and calibration histories for each instrument to be available for examination by A/E upon request. Calibration and maintenance of instruments shall be in accordance with requirements of AABC.

2.2 INSTRUMENT TEST HOLE PLUGS

A. Center-pull plugs similar to Alliance Plastics CP Series. Plug material shall be Grade 1 virgin polyethylene.

B. Do not drill test holes in welded ducts serving containment areas.

PART 3 - EXECUTION

3.1 GENERAL PROCEDURES

A. General: Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and in this Section to obtain air and water quantities indicated and required for proper operation of the systems.

B. System Operation: During all tests, it shall be demonstrated that all systems shall be free from leaks and all parts of each system are operating correctly. If not, report deficiencies to the CM/GC and the UMB – PM. Balancing Firm shall make final adjustments to equipment as may be required for proper operation, maintaining correct temperatures in all parts of the building. Controls shall be adjusted by BAS technicians in conjunction with Balancing Firm. Coordinate set points and adjustments with BAS.

C. Hydronic Systems: Balance each hydronic circulation system installed under this contract to achieve water quantities, pressure and temperature drops in all equipment and parts of system as indicated on the plans, in specifications, and on the approved shop drawings.

D. Air Systems: Balance each air circulation system, installed under this contract to achieve air quantities, pressure and temperature drops and static pressures in all equipment and parts of system as indicated on the plans, in specifications, and on the approved shop drawings.

E. Noise: Study and report on excessive noise conditions which may develop during system balancing. Report shall be sent to CM and UMB – PM in a form of a “pdf” file.

F. TAB Field Markings: Field mark equipment and balancing devices, including damper control positions, valve position indicators, fan speed control levers, and similar controls

and devices, with paint or other suitable, permanent identification material to show final settings.

G. Traverse Test Probes: Where insulation on ductwork and/or plenums needs to be removed to perform traverse measurements cut and remove insulation as necessary to complete the TAB work. When the work has been completed plug each opening with a properly sized rubber grommet to seal the holes air tight. Coordinate with the mechanical contractor to have the duct insulation repaired to match its previous condition.

H. Acceptable System Tolerance: Unless otherwise specified, the maximum acceptable tolerances for the air and water flow rates shall be +/- 10% of the flow rates as indicated on the drawings and approved submittals.

3.2 TAB REPORT

A. TAB Report: The TAB report shall include the following:

1. Certification form signed and dated by a TAB professional engineer who represents the TAB Company.
2. Table of contents with separate sections for air system balance and hydronic system balance.
3. List of abbreviations used in the report.
4. List of instruments used with instrument type, manufacturer, serial number, range, and calibration date.
5. Job notes.
6. Completed TAB Data Forms as specified.

B. Units of Measurement: Units of measurements shall be in inch/pound (IP) units.

C. Equipment Labels: Includes all major equipment and devices in each system. Include the following:

1. Equipment tag from the drawings.
2. Equipment name.
3. Manufacturer.
4. Model number.
5. Serial number.
6. Location.

D. TAB Data Forms: For each component that requires a TAB procedure provide a TAB data form with the design data from the construction documents and/or approved submittals and the actual measured data that represents the operation of each system and components as follows:

1. Hydronic Systems and Equipment: AHU coils:

a. Total water flow rate in GPM.
b. Water side pressure drop in feet (ft.).
c. Water temperature entering in °F.
d. Water temperature leaving in °F.
e. Water side temperature difference in °F between EWT/LWT.

2. Air Systems and Equipment: Air handling units, and fans:

a. Total air volume in CFM.
b. Return air volume in CFM.
c. Outside air volume in CFM.
d. Static pressure (TSP/ESP) in inches wg.
e. Suction pressure in inches wg.
f. Discharge pressure in inches wg.
g. Air side pressure drop in inches water gauge (wg).
h. Air temperature entering in °F.
i. Air temperature leaving in °F.
j. Air side temperature difference in °F between EAT/LAT.
k. Damper positions % open/closed.

3. Motors: For fans:

a. Motor HP.
b. Motor BHP.
c. Motor volts and phase.
d. Motor amps.
e. Motor RPM.
f. Fan RPM.
g. Fan sheave.
h. Motor sheave.
i. Belts.
j. Motor efficiency.

4. Air Devices: Diffusers and grilles:

a. Outlet number.
b. Outlet size
c. Outlet type.
d. Min/max air volume in CFM.

5. Terminal Units: Include cabinet heaters, unit heaters:

a. Outlet number.
b. Min/max air volume in CFM.

c. Velocity pressure at minimum.
d. Velocity pressure at maximum.
e. DDC set point value.
f. Damper position % open/closed.

6. Duct Traverses:

a. Duct height in inches.
b. Duct width in inches.
c. Duct area in square feet.
d. Average velocity in FPM.
e. Design air volume in CFM.
f. Actual air volume in CFM.
g. Duct S.P. in inches wg.
h. Measured velocity table with appropriate traverse points and velocity readings for indicated duct size.

E. Instrument Calibration Reports: Instrument calibration reports shall include the following data:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

3.3 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire stopped if required.

F. Examine equipment performance data including fan curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units such as unit heaters, cabinet heaters, compressorized cooling units and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

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

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

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

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

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.4 PREPARATION

A. Perform system readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Air Side:

a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
b. Duct systems are complete with terminals installed.
c. Volume, smoke, and fire dampers are open and functional.
d. Clean filters are installed.
e. Fans are operating, free of vibration, and rotating in correct direction.
f. Variable frequency controllers' startup is complete and safeties are verified.
g. Automatic temperature control systems are operational.
h. Ceilings are installed.
i. Windows and doors are installed.
j. Suitable access to balancing devices and equipment is provided.

2. Water Side:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
b. Piping is complete with terminals installed.
c. Water treatment is complete.
d. Systems are flushed, filled, and air purged.
e. Strainers are pulled and cleaned.
f. Control valves are functioning per the sequence of operation.
g. Shutoff and balance valves have been verified to be 100% open.
h. Pumps are started and proper rotation is verified.
i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
j. Variable frequency controllers' startup is complete and safeties are verified.
k. Suitable access to balancing devices and equipment is provided.

3.5 PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain approved submittals and manufacturer's outlet factors and recommended testing procedures. Cross check the summation of required outlet volumes with required fan design flow rates.

B. In conjunction with the BAS, fans and equipment shall be started and operated per design/approved sequence of operation.

C. With the supply and exhaust fans set for the respective design air flow volumes, system static pressures, fan rpm, motor rpm and power, and with system dampers set to handle normal minimum outdoor air perform and record the following test:

1. Air Handling Equipment:

a. Test for Total Air

1) Sum of discharge, exhaust air, return air and outside air ducts.
2) Number and locations of velocity readings taken.
3) Duct average velocity.
4) Total airflow.

b. After completion of tests, adjustments, and balancing under minimum outdoor air conditions, set system for 100% outdoor air. Repeat the total airflow tests to check field versus design conditions. Result's under the outdoor air cycle shall agree with conditions found under "minimum fresh air operation" before system is considered to be in balance. Adjustments of proper dampers shall be made to achieve balance.

c. If airflow is not within 10% of design capacity at rated speed, review system conditions, procedures, and recorded data. Check and record pressure drops across filters, compensate for clean versus dirty filters, coils, sound traps, airflow sensors, etc., to indicate excessive pressure loss or leakage. Resolve problems with appropriate contractor. If systems are properly operating, and airflow is still unacceptable, adjust fan drive in accordance with manufacturer's recommendations to obtain proper airflow and static pressure. Systems shall be balanced and operated at lowest feasible static pressure with allowance for filter loading. Record fan suction pressure, fan discharge pressure, amperage and airflow measurement. Correct fan curves to indicate new points of balance. Fan motor shall not be overloaded.

2. Air Duct Mains and Branches:

a. Design and actual airflow.
b. Adjust, measure and record airflow, static pressure of duct mains and branch ducts to provide required pressure and airflow at terminal devices.

3. Air Outlets (supply, return and exhaust registers diffusers and grilles):

a. Design and actual airflow.
b. Adjust outlets to obtain design airflow within ±5%.
c. Adjust direction of throw as required to match final installation location to prevent drafts.

d. With supply, return and exhaust balanced to design airflow, report room pressurization, (positive or negative). Record pressure readings relative to adjacent spaces and submit them to the Owner and Architect.

D. Sheaves and Belts: Should the air balance fall short of or exceed the specified tolerances, change and replace sheaves and belts to achieve the acceptable air balance. Replacement of sheaves and belts shall be provided at no additional cost.

E. Verify that air duct system is sealed as specified. Balancing contractor shall witness leakage tests required of sheet metal construction.

F. Balancing contractor shall witness leakage tests required of sheet metal contractor.

3.6 PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for each system piece of equipment. Obtain approved submittals and manufacturer recommended testing procedures. Cross check the summation of required coil and equipment flow rates.

B. In conjunction with the BAS and equipment shall be started and operated per design/approved sequence of operation.

C. With manual valves open, and control valves in normal position, adjust discharge balancing valve to obtain design flow. Compare data with pump submittal curve. If test point falls on curve, proceed with balancing. If recorded data does not fall on pump curve, plot new curve parallel with other curves on chart, from zero to maximum flow. Open discharge balancing valve to full and record discharge pressure, suction pressure and total head. Readjust balancing valve to obtain suction and discharge design flow and pressure, and record data. Check and record pump motor voltage and amperage. Pump motor shall not be overloaded.

D. Check and Verify: Check and verify the following system requirements have been completed and are in proper working order:

1. Check liquid level in expansion tank.
2. Check highest vent for adequate pressure.
3. Check flow control valves for proper position.
4. Locate start/stop and disconnect switches, electrical interlocks, and motor starters.
5. Verify that motor starters are equipped with properly sized thermal protection.
6. Check that air has been purged from the system.

3.7 PROCEDURES FOR PRIMARY/ SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first.

B. Balance the secondary circuits after the primary circuits are complete.

1. Measure total water flow:

    a. Position valves for full flow through coils.
    b. Measure flow by main flow meter, if installed.
    c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

C. For systems with pressure independent valves at terminals:

1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

D. For systems without pressure independent valves or flow measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

E. Verify final system conditions as follows:

1. Remeasure and confirm that total water flow is within design.
2. Mark final settings.
3. Verify that memory stops have been set.

3.8 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal protection element rating.
8. Service factor and frame size.

B. Motors Driven by Variable Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.9 PROCEDURES FOR PRIMARY/ SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first.

B. Balance the secondary circuits after the primary circuits are complete.

1. Measure total water flow:

a. Position valves for full flow through coils.
b. Measure flow by main flow meter, if installed.
c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

C. For systems with pressure independent valves at terminals:

1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

D. For systems without pressure independent valves or flow measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

E. Verify final system conditions as follows:

1. Remeasure and confirm that total water flow is within design.
2. Mark final settings.

F. Verify that memory stops have been set.

3.10 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering and leaving air temperatures.

C. Record fan and motor operating data.

3.11 VIBRATION TESTS

A. After systems are balanced and construction is Substantially Complete, measure and record vibration levels on equipment having motor horsepower equal to or greater than Seven and a Half (7.5).

B. Instrumentation:

1. Use portable, battery operated, and microprocessor controlled vibration meter with or without a built in printer.
2. The meter shall automatically identify engineering units, filter bandwidth, amplitude, and frequency scale values.
3. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.
4. Verify calibration date is current for vibration meter before taking readings.

C. Test Procedures:

1. To ensure accurate readings, verify that accelerometer has a clean, flat surface and is mounted properly.
2. With the unit running, set up vibration meter in a safe, secure location. Connect transducer to meter with proper cables. Hold magnetic tip of transducer on top of the bearing, and measure unit in mils of deflection. Record measurement, then move transducer to the side of the bearing and record in mils of deflection. Record an axial reading in mils of deflection by holding nonmagnetic, pointed transducer tip on end of shaft.
3. Change vibration meter to velocity (inches per second) measurements. Repeat and record above measurements.
4. Record CPM or rpm.
5. Read each bearing on motor, fan, and pump as required. Track and record vibration levels from rotating component through casing to base.

D. Reporting:

1. Report shall record location and the system tested.
2. Include horizontal vertical axial measurements for tests.
3. Verify that vibration limits follow Specifications, or, if not specified, follow the General Machinery Vibration Severity Chart or Vibration Acceleration General Severity Chart from the AABC National Standards. Acceptable levels of vibration are normally "smooth" to "good."
4. Include in report General Machinery Vibration Severity Chart, with conditions plotted.

3.12 PROCEDURES FOR HEAT TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering and leaving water temperature.
2. Water flow rate.
3. Water pressure drop for major (more than 20 gpm) equipment coils.
4. Dry bulb temperature of entering and leaving air.

5. Wet bulb temperature of entering and leaving air for cooling coils.
6. Airflow.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering and leaving air temperature at full load.
4. Voltage and amperage input of each phase at full load.
5. Calculated kilowatt at full load.
6. Fuse or circuit breaker rating for overload protection.

C. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry bulb temperature of entering and leaving air.
2. Wet bulb temperature of entering and leaving air.
3. Airflow.

3.13 DUCT LEAKAGE TESTS

A. Witness the duct pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified tolerances.

C. Report deficiencies observed.

3.14 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

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

3.15 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.

B. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

3.16 TOLERANCES

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

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10%.
2. Air Outlets and Inlets: Plus or minus 10%.
3. Cooling Water Flow Rate: Plus or minus 10%.

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

3.17 PROGRESS REPORTING

A. Initial Construction Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.18 FINAL TAB REPORT

A. Final TAB Report: The final TAB report shall be a complete record of the HVAC system performance, including conditions of operation, items outstanding, and any deviations found during the TAB process and serve as a reference of the actual operating conditions of the systems. All measurements and test results that appear in the TAB report must be made on site and dated by the AABC technicians and/or TAB engineer performing the work. This report shall be provided as a complete electronic "pdf" file organized as specified and submitted to the A/E for review.

B. Sign & Seal: Final TAB report shall bear the seal and signature of Test and Balance Engineer. TAB Report shall be certified proof that systems have been tested, adjusted, and balanced in accordance with referenced standards; are an accurate representation of how systems have been installed; are true representation of how systems are operating at completion of testing, adjusting, and balancing procedures; and are accurate record of final quantities measured, to establish normal operating values of the systems.

END OF SECTION 230593

SECTION 230700 – INSULATION FOR HVAC SYSTEMS AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

1.2 SUMMARY

A. This section includes the insulation requirements for HAVC pipe and duct systems as follows:

1. Flexible elastomeric insulation.
2. Mineral fiber blanket insulation.
3. Mineral fiber board insulation.
4. Mineral fiber pipe and tank insulation.
5. Cellular glass insulation.
6. Calcium silicate insulation.
7. Adhesives.
8. Mastics.
9. Lagging adhesives.
10. Sealants.
11. Factory applied jackets.
12. Field applied cloths.
13. Field applied jackets.
14. Tapes.
15. Securements.
16. Corner angles.

1.3 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, thermal performance data, installation instructions, jackets, specified options, and warranty information.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.

4. Detail application at linkages of control devices.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Sheet Form Insulation Materials: Twelve (12) inches square.
2. Sheet Jacket Materials: Twelve (12) inches square.
3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTAL

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of twenty five (25) or less, and smoke-developed index of fifty (50) or less.
2. Insulation Installed Outdoors: Flame-spread index of seventy five (75) or less, and smoke-developed index of one hundred fifty (150) or less.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.8 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Specification Section "Hangers and Supports for HVAC Piping Systems."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.9 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

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

1.10 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Insulation and accessories shall be designed and selected, for the intended use, in accordance with the details on the drawings and the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Fiberglass, Fiber Board and Cellular Insulation: Subject to compliance with requirements, provide products by one (1) of the following:

a. Owings Corning Inc.
b. John Manville
c. Knauf Inc.

d. Pittsburgh Corning Corporation; Foamglas.

2. Elastromeric Insulation: Subject to compliance with requirements, provide products by one (1) of the following:

a. Armstrong.
b. Armcell
c. Knauf Inc.

3. Adhesives, Mastics, and Sealants: Provide adhesives, mastics and sealant products recommended by the insulation manufacturer or by one (1) of the following:

a. Foster Brand.
b. Fueller Company.
c. Eagle Bridge.

2.2 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

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

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

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

2.3 FLEXIBLE ELASTOMERIC INSULATION

A. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.

2.4 MINERAL-FIBER BLANKET INSULATION:

A. Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, TYPE II and ASTM C 1290, TYPE I TYPE III with Factory-Applied FSP Jacket. Factory-Applied Jacket requirements are specified in "Factory-Applied Jackets" article.

B. Products: Subject to compliance with requirements, provide one (1) of the following:

1. Johns Manville; Microlite.
2. Knauf Insulation; Friendly Feel Duct Wrap.
3. Owens Corning; SOFTR All-Service Duct Wrap.

2.5 MINERAL-FIBER BOARD INSULATION

A. Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, TYPE IA or TYPE IB. For duct and plenum applications, provide insulation with Factory-Applied ASJ. Factory-Applied Jacket Requirements are specified in "Factory-Applied Jackets" article.

B. Products: Subject to compliance with requirements, provide one (1) of the following:

1. Johns Manville; 800 Series Spin-Glas.
2. Knauf Insulation; Insulation Board.
3. Owens Corning; Fiberglas 700 Series.

2.6 MINERAL-FIBER, PIPE AND TANK INSULATION

A. Mineral or glass fibers bonded with a thermosetting resin. Semi rigid board material with factory-applied ASJ complying with ASTM C 1393, TYPE II or TYPE IIIA category 2, or with properties similar to ASTM C 612, TYPE IB. Nominal density is 2.5 LB/CU. FT. or more. Thermal conductivity (k-value) at 100°F is 0.29 BTU X IN./H X SQ. FT. X °F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" article.

B. Products: Subject to compliance with requirements, provide one (1) of the following:

1. Johns Manville; MicroFlex.
2. Knauf Insulation; Pipe and Tank Insulation.
3. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.7 ADHESIVES

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

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.Eagle Bridges - Marathon Industries; 225.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.Eagle Bridges - Marathon Industries; 225.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile

Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Dow Corning Corporation; 739, Dow Silicone.
b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Speedline Corporation; Polyco VP Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.8 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one (1) of the following**:**

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: -20°F to +180°F.
4. Solids Content: ASTM D 1644, 58% by volume and 70% by weight.
5. Color: White.

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

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: -20°F to +180°F.
4. Solids Content: 60% by volume and 66% by weight.
5. Color: White.

2.9 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
b. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
4. Service Temperature Range: 0°F to +180°F.
5. Color: White.

2.10 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.Eagle Bridges - Marathon Industries; 405.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
c. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: -40°F to +250°F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: -40°F to +250°F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.11 FACTORY-APPLIED JACKETS

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

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.12 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.13 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop cutting and forming. Thickness twenty (20) mil-thick.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.

2.14 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:
a. ABI, Ideal Tape Division; 428 AWF ASJ.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
c. Compac Corporation; 104 and 105.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: Four (4) inches.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

    a. ABI, Ideal Tape Division; 491 AWF FSK.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    c. Compac Corporation; 110 and 111.
    d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: Four (4) inches.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

    a. ABI, Ideal Tape Division; 370 White PVC tape.
    b. Compac Corporation; 130.
    c. Venture Tape; 1506 CW NS.

2. Width: Four (4) inches (50 mm).

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

    a. ABI, Ideal Tape Division; 488 AWF.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    c. Compac Corporation; 120.
    d. Venture Tape; 3520 CW.

2. Width: Four (4) inches (50 mm).

2.15 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one (1) of the following:

    a. ITW Insulation Systems; Gerrard Strapping and Seals.
    b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, three quarter (3/4) inch wide with wing seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, three quarter (3/4) inch wide with wing seal.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated.

   a. Products: Subject to compliance with requirements, provide one (1) of the following:

      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; CD.
      3) Midwest Fasteners, Inc.; CD.
      4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Products: Subject to compliance with requirements, provide one (1) of the following:

      1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.

   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by two (2) inches square.
   c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

3. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Products: Subject to compliance with requirements, provide one (1) of the following:

1) GEMCO; Nylon Hangers.
2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by one and one half (1-1/2) inches in diameter.
c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to two and one half (2-1/2) inches.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than one and one half (1-1/2) inches in diameter.

a. Products: Subject to compliance with requirements, provide one (1) of the following:

1) AGM Industries, Inc.; RC-150.
2) GEMCO; R-150.
3) Midwest Fasteners, Inc.; WA-150.
4) Nelson Stud Welding; Speed Clips.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than one and one half (1-1/2) inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal three quarter (3/4) inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

2.16 CORNER ANGLES

A. Material and thickness shall be same as jacket.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

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

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

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

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

J. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with three (3) inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced four (4) inches o.c.
3. Overlap jacket longitudinal seams at least one and one half (1-1/2) inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at two (2) inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least four (4) inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least two (2) inches (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least two (2) inches.
4. Seal jacket to wall flashing with flashing sealant.

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

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least two (2) inches.

1. Comply with requirements in Section "Penetration Firestopping" Firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least two (2) inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Architectural Specification Section "Penetration Fire Stopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes.

Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least two (2) inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

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

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least one (1) inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

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

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

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesives that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is three (3) inches (75 mm) from insulation end joints, and sixteen (16) inches (400 mm) o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

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

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100% coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

3.9 DUCT INSULATION

A. Installation Of Flexible Elastomeric Insulation:

1. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Installation Of Mineral-Fiber Insulation:

1. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
2. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50% coverage of duct and plenum surfaces.

3. Revise first subparagraph below to allow adhesive to be omitted from top surface of horizontal rectangular ducts.
4. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
5. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions eighteen (18) inches and smaller, place pins along longitudinal centerline of duct. Space three (3) inches maximum from insulation end joints, and sixteen (16) inches o.c.
    b. On duct sides with dimensions larger than eighteen (18) inches, place pins sixteen (16) inches o.c. each way, and three (3) inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

6. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing two (2) inches from one (1) edge and one (1) end of insulation segment. Secure laps to adjacent insulation section with one half (1/2) inch outward-clinching staples, one (1) inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50°F at eighteen (18) foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two (2) times the insulation thickness, but not less than three (3) inches.

7. Overlap unfaced blankets a minimum of two (2) inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of eighteen (18) inches o.c.

8. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
9. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with six (6) inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced six (6) inches o.c.

C. Board Insulation Installation On Ducts And Plenums:

1. Secure with adhesive and insulation pins.
2. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50% coverage of duct and plenum surfaces.
3. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
4. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions eighteen (18) inches and smaller, place pins along longitudinal centerline of duct. Space three (3) inches maximum from insulation end joints, and sixteen (16) inches o.c.
    b. On duct sides with dimensions larger than eighteen (18) inches, space pins sixteen (16) inches o.c. each way, and three (3) inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing two (2) inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with one half (1/2) inch outward-clinching staples, one (1) inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50°F at eighteen (18) foot intervals. Vapor stops shall consist of vapor-barrier

mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two (2) times the insulation thickness, but not less than three (3) inches.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with six (6) inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced six (6) inches o.c.

3.10 FIELD-APPLIED JACKET INSTALLATION

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

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

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with one half (1-1/2) inch laps at longitudinal seams and three (3) inch wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with one (1) inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.11 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Architectural Specification Sections for "Exterior Painting" and/or "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two (2) coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.12 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.13 INSULATION SCHEDULES

INSULATION SCHEDULE - PIPING SYSTEMS						
Pipe System	**Pipe Size in Inches (NPS)**	**Materials**	**Thickness in Inches**	**Vapor Barrier Required**	**Field Applied Jacket - MER**	**Field Applied Jacket - NON - MER**
A/C Condensate Drain	½ to 1, Branch Run - outs	Fiberglass Flexible Elastomeric	½ ½	Yes Yes	N / A N / A	None None

Piping - 40ºF - 110ºF	½ to 1 ½	Fiberglass	1	Yes	N / A	None
	2 to 36	Fiberglass	1 ½	Yes	N / A	None
A/C Condensate Drain Piping - 40ºF - 110ºF	½ to 1, Branch Run - outs	Fiberglass Flexible Elastomeric	½ ½	Yes Yes	G C G C	P P
	½ to 1 ½	Fiberglass	1	Yes	G C	P
	2 to 36	Fiberglass	1 ½	Yes	N / A	P
Concealed Interior Cold HVAC Piping Systems, 0ºF - 100ºF and Refrigerant Suction	½ to 2	Fiberglass Cellular Glass Flexible Elastomeric, Refrigerant Suction only	1 1 ¾	Yes Yes Yes	None None None	None None None
	2 ½ to 8	Fiberglass Cellular Glass	1 ½ 1 ½	Yes Yes	None None	None None
	10 to 36	Fiberglass Cellular Glass	2 2	Yes Yes	None None	None None

INSULATION SCHEDULE - PIPING SYSTEMS						
Pipe System	**Pipe Size in Inches (NPS)**	**Materials**	**Thickness in Inches**	**Vapor Barrier Required**	**Field Applied Jacket - MER**	**Field Applied Jacket - NON - MER**
Exposed Interior Cold HVAC Piping Systems, 0ºF - 100ºF and Refrigerant Suction	½ to 2	Fiberglass Cellular Glass Flexible Elastomeric, Refrigerant Suction only	1 1 ¾	Yes Yes Yes	GC GC GC	P P P
	2 ½ to 8	Fiberglass Cellular Glass	1 ½ 1 ½	Yes Yes	GC GC	P P
	10 to 36	Fiberglass Cellular Glass	2 2	Yes Yes	GC GC	P P

INSULATION SCHEDULE - EQUIPMENT						
System	**Material**	**Form**	**Thickne**	**Vapor**	**Field**	**Field**

Equipment			ss in Inches	Barrier Required	Applied Jacket - MER	Applied Jacket - NON - MER
Exposed Interior Cold HVAC Equipment, Tanks and Pumps, 40ºF - 110ºF	Fiberglass Cellular Glass Flexible Elastomeric	Block or Board Block Sheet	2 1 ½ 1	Yes Yes Yes	GC GC None	GC GC None

INSULATION SCHEDULE - DUCT SYSTEMS						
Duct System	**Material**	**Form**	**Thickness in Inches**	**Vapor Barrier Required**	**Field Applied Jacket - MER**	**Field Applied Jacket - NON - MER**
Concealed Interior HVAC Supply and Return Ducts and Plenums	Fiberglass	Blanket	1 ½	Yes	None	None

Exposed Interior HVAC Supply and Return Ducts and Plenums	Fiberglass Fiberglass	Board - Rectangular or Square Pipe - Round	1 ½ 1 ½	Yes Yes	None None	None None
Concealed Interior HVAC Fresh Air Ducts and Plenums	Fiberglass	Blanket	1 ½	Yes	None	None
Exposed Interior HVAC Fresh Air Ducts and Plenums	Fiberglass	Board - Rectangular or Square	1 ½	Yes	None	None

END OF SECTION 230700

SECTION 230800 – COMMISSIONING HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section and all other sections of Division 23.

B. The OPR and BOD documentation are included by reference for information only.

1.2 SUMMARY

A. This section includes the requirements for commissioning the HVAC systems, assemblies and equipment.

1.3 DESCRIPTION

A. The following equipment and/or accessories shall be commissioned as part of this project:

1. Chilled water systems and equipment
2. Air distribution systems and equipment
3. Building automation system
4. Interface connections with the BAS.

1.4 ACTION SUBMITTALS

A. Refer to Division 01 Specification Section “COMMISSIONING” for CxA’s role.

B. Refer to Division 01 Specification Section “SUBMITTAL PROCEDURES” for specific requirements.

C. Refer to Division 01 Specification Section “COMMISSIONING” for additional submittal requirements related to submittals of equipment to be commissioned and Cx specific submittals.

1.5 COORDINATION

A. Refer to Division 01 Specification Section “COMMISSIONING” for requirements pertaining to coordination during the commissioning process.

1.6 GENERAL DOCUMENTATION

A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for all commissioned components, equipment, and systems.

1.7 WARRANTY/GUARANTEE

A. See Division 23, Specification Section "Basic Mechanical Requirements – HVAC" for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Refer to Division 01 Specification Section "COMMISSIONING" for requirements pertaining to testing equipment.

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify in writing to the CxA that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify in writing to the CxA that HVAC instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify in writing that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Place systems, subsystems, and equipment into operating mode to be tested (e.g., for pumps and AHU's normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TAB VERIFICATION

A. Notify the CxA at least ten (10) days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

B. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC systems at the direction of the CxA.

1. The CxA will coordinate with the CM and TAB contractor to determine the date of field verification. Notice will not include data points to be verified.
2. The TAB subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item includes, other than sound, a deviation of more than +/- 10%.
4. Failure of more than 10% of selected items shall result in rejection of final TAB report.
5. TAB contractor shall remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC testing shall include entire HVAC installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the HVAC contractor, TAB Subcontractor, and HVAC Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Procedures: Where applicable follow manufacturer's written procedures. If no procedures are prescribed by the manufacturer, proceed as follows:

1. HVAC Piping Distribution Systems: Includes chilled water piping systems.

a. Verify that all valves and accessories have been installed correctly, are accessible and operate as intended.
b. Verify that specified leak tests of piping systems are complete.

2. HVAC Air Distribution Systems: Includes supply, return, general exhaust and miscellaneous exhaust duct systems.

a. Verify that all ductwork, air devices, terminal units and accessories have been installed correctly, are accessible and operate as intended.
b. Verify that specified leak tests of duct systems are complete.

3. HVAC Equipment: Includes backflow preventers, electric unit heater, split system ac unit, air handlers, ventilation fans, and exhaust fans.

a. Verify that all equipment has been installed in accordance with the manufactures recommendations and all equipment can be easily accessed for maintenance.

b. Verify that all valves, trim, fittings, controls, and accessories have been installed correctly and operates as intended.
c. Verify that all required interfaces with the BAS have been installed correctly and operates as intended.
d. Operate equipment as intended to ensure the design conditions can be obtained.

4. HVAC Building Automation System:

a. Verify that all control hardware and software, sequences of operations, and integration of factory controls has been installed correctly and operates as intended.
b. Verify that all control valves, trim, fittings, and accessories have been installed correctly and operates as intended.
c. Verify that all equipment test, training, and startup procedures have been completed per the specifications.
d. Verify that all required interfaces between the BAS and HVAC equipment have been installed correctly and operates as intended.
e. Verify that all control graphics and programming has been installed in accordance with the manufactures recommendations and operates as intended.
f. Operate equipment as intended to ensure the design conditions can be obtained.

END OF SECTION 230800

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SECTION 230900 – BUILDING AUTOMATION SYSTEM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section and all other sections of Division 23.

1.2 SUMMARY

A. This section includes the requirements for the BAS System for renovation projects and includes labor, materials, tools, equipment, transportation, insurance, temporary protection, supervision and incidental items essential for proper installation and operation, even though not specifically mentioned or indicated on the drawings but which are usually provided or are essential for proper installation and operation of systems related to this Section, as indicated on the drawings and specified herein.

B. The specifications and drawings describe the minimum requirements for the installation of work, for automation systems and for equipment shown on the drawings.

C. The Building Automation System (BAS) shall include the following systems:

1. Automatic Temperature Control (ATC)
2. Switchgear Automation System

1.3 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. NFPA 70 – National Electric Code, latest edition adapted by the State of Maryland.
2. UL-916 – Energy Management Systems.
3. UL-873 – Temperature Indication and Regulating Equipment.
4. FCC; Part 15, Subpart J – Class A computing Equipment.
5. UL-864 – Fire and Smoke Control.

1.4 ACTION SUBMITTALS

A. Product Data: Provide data for each system component and software module.

1. See Division 1 – Shop Drawings, Product Data and Samples for submittal procedures.

B. Shop Drawings:

1. Shop drawings shall have clearly marked the appropriate specification number or drawing designation, for identification of the submittal.
2. Disposition of shop drawings shall not relieve the Contractor from the responsibility for deviations from the drawings or specifications, unless he has submitted in writing a letter itemizing or calling attention to such deviations at time of submission and secured written approval from the University's Representative, nor shall such disposition of shop drawings relieve the Contractor from responsibility for error in shop drawings or schedules.
3. Shop drawings shall include, but shall not be limited to, the following:

a. Control drawings with detailed piping and wiring diagrams, including bill of material and sequence of operation for automation systems and interfaces with other manufacturers' package systems and BAS.
b. Panel layouts and nameplate lists for local and central panels.
c. Valve and damper schedules showing size, configuration, capacity and location of equipment.
d. Data sheets for all control system components.
e. Control strategies (software programs) must be included within the second shop drawing submittal. The listing of each strategy must be in English and demonstrate the desired sequence of operation. Submittal must be complete with proposed schedules, listing of setpoints and end device point listing and addresses.

1.5 INFORMATIONAL SUBMITTAL

A. Manufacturer's Installation Instructions: Indicate manufacturer's installation instructions for manufactured components.

1.6 CLOSEOUT SUBMITTAL

A. Project Record Documents: Record actual locations of control components, including control units, thermostats and sensors.

1. Revise shop drawings to reflect actual installation and operating sequences.
2. Include submittals data in final "Record Documents" form.

B. Operations and Maintenance Data: Include a copy of the final approved submittal for each product in the operation and maintenance manuals.

1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
3. Include inspection period, cleaning methods, cleaning materials recommended and calibration tolerances.

C. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in University's name and registered with manufacturer.

1.7 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum ten (10) years of documented experience.

B. Installer: Company specializing in executing the scope of work specified in this section with minimum ten (10) years of documented experience and approved by the BAS manufacturer.

C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. and testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.8 MAINTENANCE SERVICE

A. Provide service and maintenance of energy management and control systems for two (2) year from Date of Substantial Completion.

B. Provide two (2) complete inspections during the two (2) years; one (1) in each season, to inspect, calibrate and tune controls as required and submit written reports.

1.9 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the University and the party providing the software shall enter into a software license agreement with provisions for the following:

1. Limiting use of software to equipment provided under these specifications.
2. Limiting copying.
3. Preserving confidentiality.
4. Prohibiting transfer to a third party.

1.10 SYSTEM DESCRIPTION

A. Furnish and install and program a total building management automation and automatic temperature control system, hereinafter referred to as the BAS, as manufactured by their corporation.

B. The system components shall be as follows:

	Device		Type
1.	Unit Heaters		
	a.	Logic	DDC
	b.	Actuation	Electronic
2.	Self Contained Air Handling Units		
	a.	Logic	Integral by Unit Manufacturer
	b.	Actuation	Electronic
3.	Supplemental A/C Units		
	a.	Logic	Integral by Unit Manufacturer
	b.	Actuation	Electronic

C. Microprocessor components shall be as manufactured or approved by the BAS Contractor. Control system shall be installed by competent control mechanics, electricians and technicians regularly employed by the equipment manufacturer.

D. Provide electric wiring and connections as required for all systems.

E. The BAS manufacturer shall be responsible for the coordination, of systems or equipment provided by others that interface with the BAS System.

F. Review all HVAC drawings and the specifications to understand equipment and system operations and to verify quantities and types of dampers, operators, alarms, sensors and monitors. Numerous references to the BAS are made throughout this specification identifying work to be performed under this Section, in addition to work specifically indicated herein.

G. Except as otherwise noted, the control system provided shall consist of microprocessors, transmission network, digital system controllers, central monitoring and control system I/O devices, software, sensors, transducers, relays, thermostats, dampers, damper operators, control panels, other accessory equipment, along with a complete system of electrical interlocking wiring to fill the intent of the specification and provide for a complete and operable system. All control equipment shall be fully proportioning. Except as otherwise specified, provide operators for equipment such as dampers, where such operators are not required to be provided by the equipment manufacturers.

H. Interlock wiring and installation of control devices associated with the air handling units, etc., shall be provided under this Section. When the DDC system is fully installed and operational, the BAS manufacturer, Contractor and University's Representative will review the operation and check out the system. At this time the BAS Manufacturer and Contractor shall demonstrate to all present the operation of the system and prove that it complies with the intent of the drawings and specifications.

I. The BAS scope of work shall include the following:

1. Building Automation System commissioning and acceptance procedures.
2. Equipment labels and graphic designations.
3. Operation and maintenance manuals.
4. Instructional classes on equipment and systems operation for University's facilities personnel.
5. Testing of systems.

J. System Overview:

1. The Building Automation System shall be capable of integrating multiple building functions including equipment supervision and control, alarm management, energy management, and historical data collection and archiving.
2. The Building Automation System (BAS) shall consist of the following:

    a. A complete and fully operation DDC system.
    b. Communication transmission network (hard-wired topography).
    c. Power wiring, temperature control, and remote monitoring.
    d. Operator workstations.

3. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, stand-alone DDC panels, and operator devices.
4. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC panel shall operate independently by performing its own specified control, alarm management, operator I/O and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
5. Stand-alone DDC panels shall be able to access any data from, or send control commands and alarm reports directly to any other DDC panel or combination of panels on the network without dependence upon a central processing device.
6. Workstation/DDC Panel Support:

    a. Operator workstations and DDC panels shall directly reside on a local area network such that communications may be executed directly between

controllers, directly between workstations, and between controllers and workstations on a peer-to-peer basis.

7. Dynamic Data Access:

   a. Operator devices, either network resident or connected via dial-up modems, shall have the ability to access point status and application report data, or execute control functions for any other devices via the local area network. Access to data shall be based upon logical identification of building equipment.
   b. Access to system data shall not be restricted by the hardware configuration of the building automation system. The hardware configuration of the BAS network shall be totally transparent to the user when accessing data or developing control programs.

8. General Network Design:

   a. Network design shall include the following provisions:

      1) High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, and upload/download efficiency between network devices. The minimum baud rate shall be 19,200.
      2) Support of any combination of controllers, and operator workstations directly connected to the local area network. A minimum of fifty (50) devices shall be supported on a single local area network.
      3) Detection and accommodation of single or multiple failures of either workstations, DDC panels or the network media. The network shall include provisions for automatically reconfiguring itself to allow operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.
      4) Message and alarm buffering to prevent information from being lost.
      5) Error detection, correction, and retransmission to guarantee data integrity.
      6) Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event an operator device does not respond.
      7) Commonly available, multiple sourced, networking components and protocols shall be used to allow the BAS to coexist with other networking applications such as office automation. ETHERNET and Siemens Protocol II are campus standard technologies.

8) Use of an industry standard IEEE 802.x protocol. Communications must be of a deterministic nature to assure calculable performance under worst case network loading.
9) Synchronization of the real-time clocks in all DDC panels.

9. System Configuration/Architecture:

a. In general, the actual number of stand-alone DDC panel(s) shall be determined by the actual, "realistic" point capacity of each panel's capacity.
b. As a minimum, each supply air handling unit (AHU) shall be equipped with one stand-alone DDC panel.

10. Existing Central Control and Monitoring System:

a. The Existing Central Control Monitoring System (CCMS) for UMB's Campus operates on software developed by Siemens and/or Johnson Controls. Modifications to the Building Automation System (BAS) shall be an extension of and integration into one of these CCMS Systems as directed by UMB.
b. The existing CCMS shall be expanded to include all CCMS workstations, software and connected field panels for this project.
c. The BAS contractor shall provide any upgrades or software revisions necessary and/or available at the time of connection of this project to bring the entire venders CCMS up to current product and software offering. The BAS contractor shall provide training and documentation on any new software revisions, their operation and functionality prior to implementation.
d. It is the intent of this specification the BAS contractor, provide their current GUI application software and server/client hardware for the main CCMS system during the construction and connect this project to that system.
e. Providing a third system is not acceptable.

11. Existing University Utility Management System:

a. The existing Utility Management System server resides in the Facilities Operations Center. This system utilizes the Universities wide area network to gather and process data supplied by utility meters and chiller plants sensors connected to the Campus Chilled Water Loop.
b. The BAS Contractor shall expand the Utility Management System (UMS) to include the data points on the Input/Output Summary identified as "Connected to Existing Utility Management System".

12. Agency Approvals:

a. The entire control system shall be UL approved and listed (UL-916 Energy Management and UL-864 Fire Control) for serial interface between the Building Automation System and Fire Alarm System.

1.11 INCIDENTAL WORK SPECIFIED IN OTHER SECTIONS

A. Work specified in the mechanical specifications:

1. Install automatic temperature control valves furnished by BAS Manufacturer.
2. Install pressure taps and sensing wells furnished by BAS Manufacturer.
3. Install steam, hot water, and chilled water meters furnished by BAS Manufacturer.
4. Provide access doors in ductwork as required for access to control equipment.
5. Furnish access panels for installation in walls and ceiling as required for access to concealed control equipment.

B. Work specified in the electrical specifications:

1. Provide power wiring to junction boxes (one 120V/20A circuit per junction box) located above ceiling and as indicated on the electrical drawings. Power wiring from these junction boxes to DDC panels, equipment controllers, sensors, and monitors shall be as specified in this section.
2. Provide power wiring as indicated on the Electrical drawings.

1.12 ELECTRICAL WIRING (BAS)

A. Electric wiring, wiring connections and interlock wiring required for the installation of the building automation system, as herein specified, shall be provided as specified in this section, unless specifically shown on the Electrical drawings or called for in the Electrical specifications. Electrical power requirements, including junction boxes, for all BAS control devices and equipment shall be provided by the electrical contractor as indicated on the electrical drawing and in the electrical specifications. Extension of power wiring from junction boxes to control devices shall be provided by the BAS contractor.

B. Coordinate necessary auxiliary contacts on magnetic starters with the requirements in the electrical specifications.

C. Furnish labor and material to install the necessary wiring to accomplish the successful and complete operation of the new automation system (DDC).

D. Furnish labor and material to install necessary relays, general purpose enclosures and appurtenances to control designated devices relative to the BAS.

E. Wiring throughout shall be concealed where possible.

F. Conduit used shall be EMT, three quarter (3/4) inch minimum size. Conduit sizes shall be large enough to permit the individual conductors to be readily installed or withdrawn without damage to the conductors or their insulation. Splicing of wires will be permitted only in junction boxes or pull boxes.

G. Conduit is never to be relied upon for a fault current and safety ground return conductor.

H. The ground system must never be used as a current carrying conductor except for faults and noise suppression. The stand-alone DDC panel grounding system shall be used to control noise and transients which might affect the operation of the automation system. As such, the ground requirements are in excess of a grounding system used solely for minimum physical protection.

I. The bond to ground shall be as short as possible. A ground point shall be derated by one (1) point (in order of preference) for each fifty (50) feet of conductor run between it and the automation equipment to be grounded. Therefore, a water pipe bond located ten (10) feet away will be preferable to a structural steel bond located one hundred fifty (150) feet away.

J. Set screw connectors shall be galvanized or plated steel. White metal cast type will not be permitted.

K. Flexible conduit shall be used at field devices, including, pressure switches, flow switches and temperature sensors. Convolutions shall be steel, interlocked continuously. Aluminum will not be permitted. "Liquidtight" or equal shall be used in wet locations.

L. Only core drilling is permitted to pierce the floors in the electrical closets and elsewhere. The use of water for drilling shall be controlled by a suitable vacuum system, using proper dams to prevent damage to floors below.

M. Low voltage wiring in exposed areas, outside air plenums, mechanical/electrical rooms and areas which may be subject to mechanical abuse shall be run in EMT or as noted below:

1.	Sensor to Panel (Stud Wall)	EMT in Wall
2.	Sensor to Panel (Mechanical Room)	In New Conduit/EMT
3.	Panel to Operator Workstation within New Building	In New Conduit/EMT

N. Wiring:

1. Control wiring, low voltage, 20 AWG pair
2. Control wiring, 120VAC, 14 AWG pair
3. Local area network, LAN, 18 AWG twisted shielded pair
4. Building network, 24 AWG, pair, low capacitance type

O. Low voltage wiring not used for life safety/smoke control applications, above suspended ceilings and in accessible concealed areas may be plenum rated cable.

P. Wiring used for life safety/smoke control shall be in EMT or flexible metal clad conduit. Air handling unit controls, including wiring from Fire Command Center to AHU control panel shall be in EMT.

Q. Do not permit the shield from different signal cables to come in contact with each other and make sure that adequate isolation and insulation have been provided.

R. Transmission Network:

1. Network Configuration: The network configuration shall be a hardwired topography.
2. System Capabilities: The new network shall be 100% compatible with a hardwired based network. No additional or third party software bridges shall be required.
3. Server Client Network shall use UM CCMS, CFMS wide area network for connection of the building work station to the server at the operation centers.
4. Use CCMS, CFMS wide area network for connection of field panels to network server.
5. The UMS shall use the CFMS wide area network to communicate to the UMS server located in the Operations Center. Provide all field data gathering panels and data points necessary to meet the Input/output summary and sequence of operation.

S. At every DDC control panel, application specific controller, and terminal unit controller (such as UH's, AC units, etc.) provide a low voltage toggle-type disconnect switch in the incoming 24 VAC service line. Switch to be mounted in a junction box.

1.13 WARRANTY/GUARANTEE

A. See Division 23 Specification Section "Basic Mechanical Requirements – HVAC" for warranty and guarantee requirements.

B. Furnish to the University a written guarantee for field programmable microprocessor based units against all defects in materials and workmanship, including without limitation against hardware failure for two (2) years from date of acceptance. Guarantee shall include all parts and labor. See Division 01, Guarantees, Warranties, Bonds, Service and Maintenance Contracts, for submittal form.

PART 2 – PRODUCTS

2.1 EXISTING PANEL UPGRADE AT NORTH ELECTRIC STATION AND INTEGRATION WITH NEW SWITCHGEAR AUTOMATION SYSTEM

A. Coordinate with Switchgear Automation System Integrator and upgrade existing BAS panel located in 2nd Floor Room # 24 of the North Electric Station to provide the following:

1. Provide a minimum of ten (10) contact outputs to the Switchgear Automation System for remote initiation of Peak Shaving by EACH INDIVIDUAL Generator from the BAS.

2. Also assume the switchgear automation system will provide up to ten (10) contact inputs to the BAS for relaying general and common alarm information to the BAS (for alerting BAS system operators of systemic electrical events).

3. Anticipate an additional ten (10) contact inputs to the BAS from the owner's Demand Response Curtailment Services Provider for remote initiation of generator paralleling.

4. Create a minimum of three (3) graphics in the BAS system for remote starting of generators via the automation system, remote monitoring of alarms and monitoring and controlling of Demand Response Provider remote control.

5. The preferred location for the BAS interfacing with the new Automation System is the North Station because the Demand Response Provider will want to use a cellular-based Remote Terminal Unit (RTU) and cell signals do not reach basements. At the North Station, all panels will be above ground.

2.2 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: All BAS equipment and accessories shall be designed and selected, for the intended use, in accordance with the scheduled capacities on the drawings and the requirements of this specification.

B. The BAS manufacturer and installer shall be Siemens Building Technologies unless otherwise directed by UMB.

C. Replacement of Existing field Panels: Where existing field panels are considerd obsolete/retired (building controllers, equipment controllers, and floor level network controllers), the BAS contractor shall include in his bid the cost to replace the existing obsolete/retired field panels with new field panels. The cost shall include all modifications to the graphics and programming resulting from this change. The obsolete/retired field panels are located in Bressler Research building and Howard Hall as follows:

1. Bressler Research building: Existing Panel – "BMBC09" Lower Level Mechanical Equipment Room. This panel is a modular building controller/retired. UMB request the project perform a fast forward on this field panel and all the BAS points for this project will come from this newly updated field panel.
2. Howard Hall: Existing Panel – "HMBC09 – AEM" First Floor Mechanical Equipment Room, #129. This panel is a modular building controller/retired. UMB request the project perform a fast forward on this field panel. An existing multi-point unit (MPU-retired) exists in the mailroom in the basement loading dock. This expansion panel will also need be upgraded as part of the project. All new BAS control points for Howard Hall substation project will come out of the basement expansion panel located in mechanical room with mailroom AHU.

2.3 SOFTWARE

A. General: Provide all necessary software to form a complete operating system as described in this specification. The software programs specified in this section shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher level computer for execution.

B. Control Software Description:

1. Pre-Tested Control Algorithms: The DDC panels shall have the ability to perform the following pre-tested control algorithms:

    a. Two (2) Position Control
    b. Proportional Control
    c. Proportional plus Integral Control
    d. Proportional, Integral, plus Derivative Control
    e. Automatic Control Loop Tuning

2. Equipment Cycling Protection: Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one (1) hour period.
3. Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
4. Powerfail Motor Restart: Upon the resumption of normal power, the DDC panel shall analyze the status of controlled equipment, compare it with normal occupancy scheduling, and turn the preselected equipment on or off as necessary in a staggered/time-delayed manner to avoid excess electrical surge. The remainder of the equipment will not automatically start. The system will print out the assigned status of the equipment on the alarm printer. The system shall require a manual command to start any equipment.

5. Temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.
6. The system shall be provided complete with equipment and documentation necessary to allow an operator to independently perform the following functions:

    a. Add/delete/modify stand-alone DDC Controller panels
    b. Add/delete/modify operator workstations
    c. Add/delete/modify application specific controllers
    d. Add/delete/modify points of any type and all associated point
    e. Add/delete/modify alarm reporting definition for points
    f. Add/delete/modify control loops
    g. Add/delete/modify energy management applications
    h. Add/delete/modify time and calendar-based programming
    i. Add/delete/modify totalization for points
    j. Add/delete/modify historical data trending for points
    k. Add/delete/modify custom control processes
    l. Add/delete/modify any and all graphic displays, symbols and cross-reference to point data
    m. Add/delete/modify dial-up telecommunication definition
    n. Add/delete/modify all operator passwords
    o. Add/delete/modify alarm messages

7. Definition of operator device characteristics, DDC Controllers individual points, applications and control sequences shall be performed using instructive prompting software.

    a. Field Panel Programs shall be manufacturers' standard line program method.
    b. Inputs and outputs for any process shall not be restricted to a single DDC Controller. Each Controller shall be able to include data from other network panels to allow the development of network-wide control strategies. Processes shall also allow the operator to use the results of one process as the input to any number of other processes (cascading).
    c. Provide the capability to backup and store system databases on the workstation hard disk. In addition, database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate DDC Controller. Similarly, changes made at the DDC Controllers shall be automatically uploaded to the workstation, ensuring system continuity. The user shall also have the option to selectively download changes as desired.
    d. Provide context-sensitive help menus to provide instructions appropriate with operations and applications currently being performed.

C. Energy Management Applications: DDC Panels shall have the ability to perform any or all of the following energy management routines:

1. Time of Day Scheduling
2. Calendar Based Scheduling
3. Holiday Scheduling
4. Temporary Schedule Overrides
5. Optimal Start
6. Optimal Stop
7. Optimal Stop
8. Night Setback Control
9. Peak Demand Limiting
10. Temperature Compensated Load Rolling
11. Variable frequency drive/CFM Control
12. Heating/Cooling Interlock
13. Discharge Air Temperature Reset Based Optimized Reheat Coil Positions and Maximum Space Humidity Setpoint
14. Chilled Water Reset

D. Custom Process Programming Capability: DDC panels shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

1. Process Inputs and Variables: It shall be possible to use any of the following in a custom process:

    a. Any system-measured point data or status
    b. Any calculated data
    c. Any results from other processes
    d. User-Defined Constants
    e. Arithmetic functions (+,-,*,/, square root, exp, etc.)
    f. Boolean logic operators (and, or, exclusive or, etc.)
    g. On-delay/Off-delay/One-shot timers

2. Process Triggers: Custom processes may be triggered based on any combination of the following:

    a. Time interval
    b. Time of day
    c. Date
    d. Other processes
    e. Time programming
    f. Events (e.g., point alarms)

3. Dynamic Data Access: A single process shall be able to incorporate measured or calculated data from other DDC panels on the local area network. In addition, a

single process shall be able to issue commands to points in other DDC panels on the local area network.

4. Advisory/Message Generation: Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device, buffer the information in a follow-up file, or cause the execution of a dial-up connection to a remote device such as a printer or pager.
5. Custom Process Documentation: The custom control programming feature shall be self-documenting. All interrelationships defined by this feature shall be documented via graphic flow charts and English language descriptors.

E. Alarm Management: Alarm management shall be provided to monitor, print, buffer, and direct alarm reports to operator devices and memory files. Each DDC panel shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the DDC panel's ability to report alarms be affected by either operator activity at a PC Workstation or local I/O device, or communications with other panels on the network..

1. Point Change Report Description: Alarm or point change reports shall include the point's English language description and the time and date of occurrence.
2. Prioritization: The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three (3) priority levels shall be provided. Each DDC panel shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point. The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.
3. Report Routing: Alarm reports, messages, and files will be directed to a user-defined list of operator devices, or PC's used for archiving alarm information.

    a. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.

4. Alarm Messages: In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a two hundred (200) character alarm message for each system point to more fully describe the alarm condition or direct operator response. Each stand-alone DDC panel shall be capable of storing a library of at least two hundred fifty (250) alarm messages. Each message may be assignable to any number of points in the panel.

F. Historical Data and Trend Analysis: A variety of Historical data collection utilities shall be provided to automatically sample, store, and display system data in the following ways.

1. Continuous Point Histories: Stand-alone DDC panels shall store Point History Files for analog and binary inputs and outputs. The Point History routine shall continuously and automatically sample the value of analog inputs at half hour intervals. Samples for points shall be stored for the past twenty four (24) hours to allow the user to immediately analyze equipment performance and problem-related events for the past day. Point History Files for binary input or output points and analog output points shall include a continuous record of the last ten (10) status changes or commands for each point.
2. Control Loop Performance Trends: Stand-alone DDC panels shall also provide high resolution sampling capability with an operator-adjustable resolution of ten (10) to three hundred (300) seconds in one (1) second increments for verification of control loop performance.
3. Extended Sample Period Trends: Measured and calculated analog and binary data shall also be assignable to user-definable trends for the purpose of collecting operator-specified performance data over extended periods of time. Sample intervals of one (1) minute to two (2) hours, in one (1) minute intervals, shall be provided. Each stand-alone DDC panel shall have a dedicated buffer for trend data and shall be capable of storing a minimum of 10,000 data samples.
4. Data Storage and Archiving: Trend data shall be stored at the Stand-alone DDC panels, and uploaded to hard disk storage (minimum 80 megabyte) when archival is desired. Uploads shall occur based upon either user-defined interval, manual command, or when the trend buffers become full. Trend data shall be available in disk file form for use in 3rd Party personal computer applications.

G. Runtime Totalization: Stand-alone DDC panels shall automatically accumulate and store runtime hours for binary input and output points as specified in the Execution portion of this specification.

1. The Totalization routine shall have a sampling resolution of (1) minute or less.
2. The user shall have the ability to define a warning limit for Runtime Totalization. Unique, user-specified messages shall be generated when the limit is reached.

H. Analog/Pulse Totalization: Stand-alone DDC panels shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.

1. Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g. KWH, gallons, KBTU, tons. etc.).
2. The Totalization routine shall have a sampling resolution of one (1) minute or less.
3. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

I. Event Totalization: Stand-alone DDC panels shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.

1. The Event Totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.
2. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

2.4 STAND-ALONE DDC PANELS

A. General: Stand-alone DDC panels shall be microprocessor based multi-tasking, multi-user, real-time digital control processors. Each stand-alone DDC panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and drawings.

B. Building Controllers: Building controllers shall include the following:

1. Building Controllers shall be 32 bit, multi-tasking, multi-user, real-time 100 MHz digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.
2. Each Building Controller shall have sufficient memory, a minimum of twenty four (24) megabyte, to support its own operating system and databases, including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes and operator I/O.
3. Building Controller shall have an integral real-time clock.
4. Each Building Controller shall support firmware upgrades without the need to change hardware.
5. Each Building Controller shall support:

    a. Monitoring of industry standard analog and digital inputs, without the addition of equipment outside the Building Controller cabinet.
    b. Monitoring of industry standard analog and digital outputs, without the addition of equipment outside the Building Controller cabinet.

6. Spare Point Capacity. Each Building Controller shall have a minimum of 10 percent spare point capacity.

    a. The type of spares shall be in the same proportion as the implemented I/O functions of the panel, but in no case shall there be less than one spare of each implemented I/O type.

b. Provide all processors, power supplies, and communication controllers so that the implementation of adding a point to the spare point location only requires the addition of the appropriate:

1) Expansion modules
2) Sensor/actuator
3) Field wiring/tubing

7. Serial Communication: Building Controllers shall provide at least one EIA-232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, and portable laptop operator's terminals. Building Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected printers or terminals. A USB port shall alternatively be available to support local HMI tools connection.
8. I/O Status and Indication: Building Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output. All wiring connections shall be made to field-removable terminals.
9. Self-Diagnostics: Each Building Controller shall continuously perform self diagnostics, communication diagnosis, and diagnosis of all panel components. The Building Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication for any system.
10. Power loss: In the event of the loss of power, there shall be an orderly shutdown of all Building Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of one hundred (100) hours.
11. Environment: Controller hardware shall be suitable for the anticipated ambient conditions as follows:

a. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).
b. Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).

12. Immunity to power and noise.

a. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
b. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

c. Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:

1) RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3 V.
2) Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact.
3) Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power.
4) Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max).

d. Isolation shall be provided at all Building Controller's AC input terminals to suppress induced voltage transients consistent with:

1) IEEE Standard 587 1980.
2) UL 864 Supply Line Transients.
3) Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11).

13. Minimum Approved Building Controllers. BAS Contractors shall furnish Building Controllers as listed below. Providing an approved controller does not release the contractor from meeting all performance, software and hardware specifications for Building Controllers and system operations.

a. Siemens Building Technologies Inc. – PXC Compact and PXC Modular Building Controllers, Modular Building/Modular Equipment Controllers (MBC/MEC).

2.5 BUILDING AND APPLICATION SPECIFIC CONTROLLERS (ASC)

A. General: Provide building and application specific controllers to control each piece of equipment , including, but not limited to the following:

1. Each Building Controller shall be able to communicate with application specific controllers (ASCs) over the Secondary Network to control terminal equipment only.
2. The use of Secondary Network controllers with custom program applications to control AHU's, water systems, etc. is not acceptable.
3. Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor.

4. Each ASC shall include all point inputs and outputs necessary to perform the specified control sequences. The ASC shall accept input and provide output signals that comply with industry standards. Controllers utilizing proprietary control signals shall not be acceptable. Outputs utilized either for two-state, modulating floating, or proportional control, allowing for additional system flexibility.
5. Communication: Each controller shall perform its primary control function independent of other Secondary Network communication, or if Secondary Network communication is interrupted. Reversion to a fail-safe mode of operation during Secondary Network interruption is not acceptable.
6. Control Algorithms: The controller shall receive its real-time data from the Building Controller time clock to insure Secondary Network continuity. Each controller shall include algorithms incorporating proportional, integral and derivative (PID) gains for all applications. All PID gains and biases shall be field-adjustable by the user via room sensor LCD or the portable operator's terminal as specified herein. Controllers that incorporate proportional and integral (PI) control algorithms only shall not be acceptable.
7. Control Applications: Operating programs shall be field-selectable for specific applications. In addition, specific applications may be modified to meet the user's exact control strategy requirements, allowing for additional system flexibility. Controllers that require factory changes of all applications are not acceptable.
8. Calibration: Each controller shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and insuring against drift over time.

    a. Manual calibration may be accomplished by either commanding the actuator to 0% via the POT or by depressing the room sensor override switch. Calibration of the transducer at the controller location shall not be necessary
    b. Calibration shall be accomplished by stroking the terminal unit damper actuator to a 0% position so that a 0 CFM air volume reading is sensed. The controller shall automatically accomplish this whenever the system mode switches from occupied to unoccupied or vice versa.
    c. Calibration shall be accomplished by zeroing out the pressure sensor and holding damper at last known position until calibration is complete. The controller shall automatically accomplish this whenever the system mode switches from occupied to unoccupied or vice versa.

9. Memory: Memory requirements shall include the following requirements:

    a. Provide each ASC with sufficient memory to accommodate point databases, operating programs, local alarming and local trending. All databases and programs shall be stored in non-volatile EEPROM, EPROM and PROM, or minimum of seventy two (72) hour battery backup shall be

provided. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration.

b. Upon replacement, new ASCs shall recover control function and site specific defaults automatically and resume normal operation.

10. Power Supply: The ASCs shall be powered from a 24 VAC source and shall function normally under an operating range of 18 VAC to 28 VAC, allowing for power source fluctuations and voltage drops. Power supply for the ASC must be rated at a minimum of 125% of ASC power consumption and shall be of the fused or current limiting type. The BMS contractor shall provide 24 VAC power to the terminal units by utilizing:

    a. The existing line voltage power trunk and installing separate isolation transformers for each controller.
    b. Dedicated line voltage power source and isolation transformers at a central location and installing 24 VAC power trunk to supply multiple ASCs in the area.

11. Environment: The controllers shall function normally under ambient conditions of 32°F to 122°F (0°C to 50°C) and 10% to 95%RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the circuit board assembly.
12. Immunity to noise: Operation shall be protected against electrical noise of 5-120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
13. Manufacturer Installed Controls: Include the following:

    a. BAS manufacturer shall furnish ASC and actuator for factory mounting to equipment manufacturer.
    b. Cost of factory mounting shall be borne by equipment manufacturer.

2.6 TEMPERATURE SENSORS (DDC)

A. General: Provide temperature sensors for controllers performing space temperature control. Sensors shall be wired thermistor type, with the following features:

1. Accuracy: + .5°F.
2. Operating Range: 35°F to 115°F.
3. Set Point Adjustment Range: 55°F to 95°F.
4. Calibration Adjustments: None required.
5. Installation: Up to one hundred (100) ft. from controller.
6. Auxiliary Communications Port: As required.
7. Set Point Adjustment Dial: As required.
8. Occupancy Override Switch: As required.
9. Terminal Jack: As required.

B. Set Point Modes: Provide the following set point modes:

1. Independent Heating, Cooling.
2. Night Setback-Heating.
3. Night Setback-Cooling.

C. Auxiliary Communication Port: Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. RS-232 communications port shall allow the operator to query and modify operating parameters of the local room terminal unit from the portable operator's terminal.

D. Set Point Adjustment Dial: The set point adjustment dial shall allow for modification of the temperature by the building operators. Set point adjustment may be locked out, overridden, or limited as to time or temperature through software by an authorized operator at any central workstation, Building Controller, room sensor two-line display, or via the portable operator's terminal.

E. Override Switch: An override switch shall initiate override of the night setback mode to normal (day) operation when activated by the occupant and enabled by building operators. The override shall be limited to two (2) hours (adjustable.) The override function may be locked out, overridden, or limited through software by an authorized operator at the operator interface, Building Controller, room sensor two-line display or via the portable operator's terminal.

F. Room Temperature Sensors and Monitors: The following temperature sensors for space control and/or space monitoring where indicated on the drawings and as required for proper control for the project:

1. Room Temperature Control Sensor: Room sensor shall come with a wall plate suitable for surface mounting in the room. The local setpoint adjustment shall be capable of being locked out by the BAS. The sensors shall be wired to the TEC by a cable which transmits the temperature signal to BAS.
2. Duct Mounted Space Temperature Control: For duct mounted space temperature control provide a surface mounted duct thermistor for the space TRU TEC. Thermistor shall be 10,000 Ohm with a set point adjustment range of 55ºF to 95ºF and be accurate to within ± 5ºF at mid range. The sensors shall be suitable for mounting on either a round or rectangular ductwork with self drilling screws and a gasket. The sensors shall be wired to the TEC by a cable which transmits the temperature signal to BAS. Mount the thermistor where indicated on the drawings in the exhaust duct serving room.
3. Duct Mounted Supply and Exhaust Air Temperature Monitor: For each supply and exhaust terminal unit serving a space, provide a duct mounted temperature sensor to monitor the supply and exhaust air temperature. The sensors shall provide an input for temperature monitoring range of 32ºF to 122ºF and be

accurate to within ± 5ºF at mid range. The sensors shall be suitable for mounting on either a round or rectangular ductwork with self drilling screws and a gasket. The sensors shall be wired to the TEC by a cable which transmits the temperature signal to BAS.

2.7 FIELD DEVICES

A. Local Control Panels:

1. Controls, relays and switches for equipment located within the mechanical equipment rooms shall be mounted on enclosed control panels with hinge lock type door mounted adjacent to the system controlled.
2. Details of each panel shall be submitted for review prior to fabrication. Locations of each panel shall be convenient for adjustment and service. Manual switches shall be flush mounted on the hinged door.
3. Electrical devices within the panels shall be factory prewired to a numbered terminal strip. Wiring within the panel shall be in accordance with NEMA and UL Standards.
4. Space Temperature Monitor: In the recycling center in the north building and in the switch gear rooms of both substations provide a surface mounted temperature sensor to monitor the space temperature. The sensor shall provide an input for temperature monitoring range of 32°F to 122°F and be accurate to within ± 3°F at mid-range. The sensors shall be mounted on the wall adjacent to the local control unit. The sensor shall be wired to the nearest TEC by a cable which transmits the temperature signal to BAS along with an alarm for low temperature/high temperature.

B. Temperature Sensors:

1. Linear precision resistance elements or thermistors and resistance averaging elements shall be provided for temperature sensing. Their range shall be applicable to their installation.
2. Sensor shall have minimum accuracy of±0.5°F at 70°F.

C. Humidity Sensors:

1. Sensors shall have minimum accuracy of±3% RH over a range from 20-95% RH including hysteresis, linearity and repeatability.
2. Sensors shall be manufactured by Rotronic (F2 Series),, Contractor Instruments (Model 981/982-219), General Eastern (Model MRH-3-X), or equal.

D. Fan Status:

1. HVAC Fans: Verification of air flow for HVAC fans, which are wired from an electrical motor control center, shall be by a current sensor device unless indicated otherwise on the point schedule. Motor Start/Stop relay module shall provide

either momentary or maintained switching action as appropriate for the motor being started. Relays shall be plugged in, interchangeable, mounted on a circuit board and wired to numbered terminal strips.

2. Terminal Unit Fans: Verification of air flow for fans, which are part of terminal heating and cooling units such as fan coil units, fan powered boxes, unit heaters, cabinet heaters, shall be by a current sensing device unless indicated otherwise on the point schedule.

E. Insertion Turbine Flow Meters:

1. The CCMS and UMS shall monitor and record output signal from insertion turbine flow meters where indicated on the contract documents.
2. Insertion turbine flow meter providing a pulse or 4-20ma signal linear to flow. Turbine meter shall high-resolution frequency output for connection to a BAS system and a local display module. Flow meter hall be certified to be wet calibrated with NIST traceable instrumentation and practices.
3. Physical Characteristics:

   a. Pipe Size: 2-1/2 inches through 72 inches nominal
   b. b. Pressure drop: less than 1psi at 20fps
   c. Supply Voltage: 24 VAC/DC 30ma
   d. Liquid Temperature Range

4. Standard: continuous 180ºF, 200ºF peak
5. High Temp: continuous 280ºF, 300ºF peak

   a. Operating Pressure: 400 PSI max.

6. Provide direct insertion flow meter with hot tap and valve accessory for serviceability. Flow meter shall be provided with local display and 4-20ma output to BAS system.
7. Provide dual turbine flow meters where required for bi-direction or extremely low flow sensing is required.
8. Flow meter shall be Onicon Incorporated or approved equal.

F. Control Valves:

1. Electronic Valves shall be quiet in operation and fail-safe in either normally open or normally closed position in the event of control air failure. Valves shall be capable of operating in sequence when required by the sequence of operation. Control valves shall be suitable for the pressure conditions and shall close against the differential pressure involved. Valve operators shall be of the molded synthetic rubber diaphragm type.
2. Electronic Automatic valves shall be fully proportioning with packing glands designated for hot or chilled water service. Valve bodies shall be designated for

150 psig service and shall have bronze trim and throttling plug inner valves for modulating control. Valves shall be normally open or closed as required and each shall be sized for the allowable pressure drop.

3. Two-way valves shall have external spring adjustment with a self-sealing V-ring packing arranged to tighten the seal as the water pressure increases so that no manual adjustment is necessary.
4. Three-way valves shall be of the three-way mixing type designed for 100% tight shut-off and shall have full throttling plugs, renewable composition discs and seat rings.
5. All other heating coil valves shall be either normally open or closed as specified. The interiors of all such valves shall be designed for 100% tight shut-off against the operating pressure.
6. Valves sequenced with other valves, or control devices, shall be equipped with pilot positioners or panel mounted positive positioning relays to insure proper control sequencing.
7. See Division 26, Specification Section “Valves for HVAC Piping Systems” for high performance Butterfly Valves.
8. Provide pressure gauges on main air, branch air and pilot positioner output to each valve actuator.

PART 3 – EXECUTION

3.1 GENERAL REQUIREMENTS

A. The sequences listed hereinafter describe the general intent of the automatic temperature control systems. Provide all devices, equipment, and wiring as required to perform the sequences described herein.

B. Unless otherwise noted, size all automatic control valves for a maximum of ten (10) foot water pressure drop at the maximum design flow rate.

C. See plans for location of all room thermostats, control panels, dampers, valves, and equipment; where such devices are not indicated, however required by the sequences, they shall be provided and located in the field as directed by the A/E and UMB.

D. Current Sensor: All motors serving HVAC fans and pumps shall be provided with a current sensor for “on/off” status to the BAS.

E. Terminal Unit Fan Status: All fans serving fan coil units, cabinet heaters, and unit heaters shall be provided with current sensors for “on/off” status to the BAS.

F. All temperature, pressure, air flow, water flow and time set points shall be fully adjustable from the Central Control and Monitoring System (CCMS).

G. Provide all hardware, software, devices, equipment and wiring as required to interface with the CCMS.

H. Refer to input/output summary schedule for additional control items not described in the sequences. The input/output summary schedule list the minimum requirements, provide all required points for complete operation of the system.

I. Where indicated on the drawings, the variable frequency drives (VFD) for secondary pumps shall be soft started at minimum speed and increased to operating speed by the CCMS.

J. The control manufacturer shall prepare and submit for approval a composite control and interlock wiring diagram depicting the control system that will be provided.

K. All two (2) position valves shall be fitted with an end switch to indicate proof of opening and closure. The end switch shall be internal or external to the valve actuator.

L. After each Room Air Terminal Unit (RATU) has been field set at its design operating position, the BAS Contractor shall revise the program logic of each RATU so that future RATU calibration is scheduled during the unoccupied mode.

M. The BAS Contractor shall be responsible for ensuring that the room numbers assigned to all control components such as RATU'S, Thermostats etc. in the program logic are the actual room numbers used in the Building prior to the system being turned over to UMB.

3.2 SEQUENCE OF ORERATION

A. Refer to contract drawings for sequence of operations.

3.3 SEQUENCE OF ORERATION – SELF CONTAINED A/C UNITS

A. Water Cooled A/C Unit:

1. The Building Automation System (BAS) shall initiate occupied/unoccupied mode. BAS shall disable A/C Unit whenever unoccupied mode is initiated.
2. The unit shall be controlled by the factory furnished and installed microprocessor controls. The unit controls shall enable/disable cooling at the A/C unit by energizing the unit's compressor to maintain space temperature set point as sensed by space temperature sensor.
3. On a call for cooling if the unit compressor fails to start an alarm shall be transmitted to the BAS through the BAC NET IP BMS Card and the unit shall be de-energized.
4. On a call for cooling if the unit compressor starts but the unit fan fails to start an alarm shall be transmitted to the BAS through the BAC NET IP BMS Card and the unit shall be de-energized.

5. When water cooled units and/or fan coil units have auxiliary drain pans provide a moisture sensor connected to the BAS. When moisture is detected, the sensor shall send an alarm to the BAS and de-energize the unit.
6. Provide BAC NET IP BMS Communication Software to interface with the water cooled A/C unit controls.
7. The following points are included with the A/C Unit microprocessor controller. BAS shall provide BAC NET IP BMS communication software to allow for BAS monitoring. Points ‘a’ through ‘m’ and ‘p’ and ‘q’ shall be alarmed and trended by the BAS:

    a. Unit on/off —Digital Output
    b. Compressor running Module1 —Digital Output
    c. Fan running Module1 —Digital Output
    d. Compressor low pressure alarm Module1 —Digital Input
    e. Compressor high pressure alarm Module1 —Digital Input
    f. Air flow alarm Module1 —Digital Input
    g. Water detector alarm Module1 (condensate pan) —Digital Input
    h. Room temperature to high alarm —Digital Input
    i. Room temperature to low alarm —Digital Input
    j. Supply temperature to high alarm —Digital Input
    k. Supply temperature to low alarm —Digital Input
    l. Water temperature to high alarm —Digital Input
    m. Water temperature to low alarm —Digital Input
    n. Set point temperature —Analog Input
    o. Set point supply air temperature —Analog Input
    p. Actual return air temperature —Analog Input
    q. Supply air temperature —Analog Input

8. For systems requiring Humidity Control include the additional points indicated below. BAS shall provide BAC IP BMS communication software to allow for BAS monitoring. Points ‘a’ through ‘e’ shall be alarmed and trended by the BAS:

    a. Humidity Sensor
    b. Humidifier Active
    c. Humidifier Failure Alarm
    d. Room Humidity to High
    e. Room Humidity to Low

9. For systems requiring auxiliary drain pans the following point shall be alarmed through the BAS:

    a. Auxiliary Drain Pan Water Detector Alarm — Digital Input

3.4 SEQUENCE OF ORERATION – EXHAUST FANS

A. Exhaust Fan Control:

1. The CCMS shall energize exhaust fan. The exhaust fan shall be energized after the fan's isolation damper end switch has been proven the damper has opened.
2. The exhaust fan status shall be as determined by a current transducer. If the lead fan fails to energize its isolation damper shall close and a current transducer shall transmit an alarm signal the CCMS. The CCMS shall signal the lag fan isolation damper to open and after the damper has opened the lag fan shall be energized to run continuously.

3.5 SYSTEM INPUT/OUTPUT SCHEDULE (POINT LIST)

A. For points not listed below and for software association, see sequence of operation. Points shall be able to integrate to trends and totalizations, as applicable. Additional points not specifically called for herein but required to perform the sequences as specified shall be provided at no additional cost to the Owner.

B. Description – Input/Output Point Summary:

1. Server Rooms:

a. Analog Inputs - Measured:
1) Space Temperature
2) Compressor status
3) RH

3.6 EMERGENCY POWER

A. BAS Emergency Power Requirements:

1. Connect the following BAS equipment to the building emergency power system as indicated on the contract drawings:

a. Building Level Network by UPS.
b. Floor Level Control Network and ATU, FHET Power.
c. Duplex Air Compressors, emergency power only.
d. Refrigerated Air Dryers, emergency power only.
e. UPS Devices.

2. All tie-ins to the emergency power system will be accomplished through a non-switching UPS with "micro pods" to allow for servicing the UPS without interrupting the downstream components
3. BAS contractor shall coordinate the power requirements for this equipment with the electrical contractor.

3.7 PROJECT MANAGEMENT

A. The Contractor shall designate a project manager for the Building Automation System who will be responsible for the following:

1. Construct and maintain BAS project schedule.
2. On-site coordination of BAS requirements with all applicable trades and subcontractors.
3. Authorized to accept and execute orders or instructions for the BAS from the University's Representative.
4. Attend project meetings as necessary to avoid conflicts and delays.
5. Make necessary field decisions relating to this scope of work.

3.8 NUMERING/NAMING CONVENTIONS

A. Coordinate with the University's Representative to determine the University's preference for naming conventions, etc. before entering the data in the system.

3.9 PROGRAMING

A. Programming modifications shall also include the occupied and unoccupied modes of control for each terminal unit and any modifications to the program graphics for the BAS.

3.10 TESTING AND ADJUSTMENT

A. Furnish labor, material, instruments, supplies and services and bear costs for the accomplishment of the tests herein specified. Correct defects appearing under test, and repeat the tests until no defects are disclosed; leave the equipment clean and ready for use.

B. Perform tests other than herein specified which may be required by the State Building Code, Fire Code, or Underwriter's Laboratory to whose requirements this work is to conform.

C. Furnish necessary testing apparatus, make temporary connections and perform testing operations required, at no additional cost to the University.

D. Tests performed shall not relieve the Contractor of his responsibility for leaks which may develop after the tests are made.

E. Upon completion of the project:

1. Completely adjust, ready for use, thermostats, controllers, DDC panels, transducers, valves, damper operators, relays, etc., provided under this Section.

2. Load and debug software and related data base provided for under this Contract.

3.11 START UP AND COMMISSIONING

A. Start Up: Comply with the following:
1. When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on-line. Testing, calibrating, adjusting and final field tests shall be completed by the installer. Verify that systems are operable from local controls in the specified failure mode upon panel failure or loss of power.

2. Provide any recommendation for system modification in writing to University. Do not make any system modification, including operating parameters and control settings, without prior approval of University's Representative.

B. Commissioning: See Division 26, Specification Section "Commissioning HVAC Systems" for requirements. Schedule a time and date with the UMB Commissioning representative through the UMB-PM.

END OF SECTION 230900

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SECTION 230902 – CONTROL VALVES AND DAMPERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 GENERAL

A. No devices containing mercury will be allowed under this Specification.

1.3 SUBMITTALS

A. Product data sheets shall include construction materials and assembly methods, maximum design parameters (temperature, pressure, velocity, etc.), and performance data for full range of actuator stroke. Product data sheets shall include charts, graphics or similar items used in making selections, including damper to duct area ratio and free area ratio. Damper product data sheets shall indicate certified leakage rates for given pressure differentials.

B. Submit valve schedules with shop drawings, indicating unique tag numbers for each device, equipment item or system served, device model numbers, sizes, shut-off head required, actuator air pressure or force required to meet shut-off head, torque requirements for rotary valves, flow coefficients (Cv) for 10% and 100% valve stem travel, actual flow requirements based on equipment shop drawings, calculation of actual pressure drops, actuator model number, actuator torque capacities and pilot positioner locations.

C. Valve and damper Shop Drawing submittals will not be processed unless supporting data and sizing calculations are included.

D. Submit damper schedules with Shop Drawings, indicating unique tag numbers for each device, equipment or system served, device model numbers, duct sizes, damper sizes, flow rates, pressure differentials, calculation of actual damper pressure drops, approach velocities, leakage rates, torque requirements, actuator model number, actuator torque capacities and pilot positioner locations.

E. Select dampers to meet their intended service with respect to maximum approach velocities and maximum pressure differential. Damper materials shall match duct construction materials of systems in which they are installed (galvanized steel, aluminum, Type 304 or 316 stainless steel, etc.).

F. Aluminum dampers may be used in galvanized steel ductwork.

1.4 VALVE SELECTION AND SIZING

A. General:
   1. Select control valves to meet their intended service without cavitation. Provide cavitation calculations for modulating globe control valves over 250°F and all modulating butterfly valves over 60°F.
   2. Select control valves and actuators for 100% shut-off against system maximum differential pressure.
   3. Valve body ratings indicated in Part 2 are minimum required. Valve body, trim and packing selected shall be designed to withstand maximum pressure and temperature encountered in system.
   4. Submit engineering calculations for sizing modulating control valves unless valves are scheduled. Control valves serving terminal devices may be sized based on flow ranges for each pump system.
   5. Shut off and two (2) position valves shall be full pipe size.
   6. Calculations for sizing modulating valves shall be based on actual characteristics of equipment and system in which valves are installed. Valve calculations shall include information such as pump head or available pressure.
   7. Control Contractor is responsible for obtaining adequate system information necessary for sizing.

B. Minimum pressure and temperature rating of piping systems (complete system of pipe, fittings, joints, etc.) shall be as follows. Where more stringent pressure and temperature ratings are specified under individual product specifications, the more stringent ratings shall be provided.
   1. Chilled Water: 200 psig at 100°F

C. Instrumentation Valves:
   1. Unless otherwise noted, instrumentation shut-off valves for isolation of gauges, switches, transmitters, etc., shall be as specified in Division 26, Specification Section “Valves for HVAC Piping System”.

D. Water Valves:
   1. Unless otherwise indicated, select modulating control valves to provide 3 psi to 5 psi pressure drop at design flow rate.
   2. Design criteria for sizing modulating valves shall be based on two (2) port, equal percentage valves unless otherwise specified. Select heating and cooling coil control valves of major equipment including air handling units for minimum of 30% to 50% of equipment sub-circuit pressure drop, but not more than maximum available pump head allowing minimum 2 psi drop for balancing valve.
   3. Select control valves based upon pressure drop calculations and (Cv) values at 90% stroke.

4. Size three (3) way mixing or diverting valves not directly associated with pump sub-circuit for 3 psi to 5 psi pressure drop.
5. Sub-circuit is defined as branch supply and return piping to terminal device, including valve, coil, control valve, and balancing valve.

1.5 DAMPER SELECTION AND SIZING

A. Submit engineering calculations for sizing modulating control dampers including outside, return, and relief air dampers of air handling units unless dampers are scheduled.

B. Calculations for sizing dampers shall be based on actual characteristics of ductwork system being installed. Opposed blade dampers shall be sized for minimum of 10% of duct system pressure drop. Parallel blade dampers shall be sized for minimum of 30% of duct system pressure drop. Duct section is defined as ductwork containing flow control damper starting with inlet or branch tee and ending with outlet or branch tee. Calculate actual duct pressure drops for each duct section containing modulating damper using latest version of ASHRAE Handbook of Fundamentals. If control systems fixes pressure drop, use those pressure set points. Use balance damper to provide additional pressure drop as required for obtaining linear damper response.

C. Control Contractor is responsible for obtaining adequate system information necessary for sizing.

D. Two (2) position dampers to be sized as close as possible to duct size, but in no case is damper size to be less than duct area.

E. Submit leakage and flow characteristic data for control dampers along with shop drawings. Leakage ratings shall be based on AMCA Standard 500 and dampers shall bear AMCA Air Leakage Seals.

1.6 WARRANTY/GUARENTEE

A. See Division 26, Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: All BAS valves, dampers and accessories shall be designed and selected, for the intended use, in accordance with the the requirements of this specification.

B. Acceptable Manufacturers: Acceptable manufacturers of valves, dampers and accessories shall be as follows:

1. High Performance Butterfly Valves: See Division 26, Specification Section "Valves of HVAC Piping Systems" for acceptable valves.

2. Solenoid Valves: Subject to compliance with requirements, provide solenoid valves by one (1) of the following:
   a. Siemens Building Technologies.
   b. Johnson Controls.
   c. Honeywell.

3. Control Dampers: Subject to compliance with requirements, provide control dampers by one (1) of the following:
   a. Ruskin.
   b. Air Balance.
   c. Johnson Controls.
   d. Honeywell.
   e. Greenheck.

4. Actuators for Valves and Dampers: Subject to compliance with requirements, provide acturators by one (1) of the following:
   a. Siemens Building Technologies.
   b. Johnson Controls.
   c. Honeywell.

2.2 CONTROL VALVES

A. General:
   1. If control valves are not scheduled, refer to Part 1 of this Section for sizing criteria.
   2. Use two (2) port or three (3) port globe type control valves with equal percentage contoured throttling plugs for water applications, except as otherwise noted.
   3. Butterfly valves shall be used for water system control valves three (3) inches and larger provided that valves meet pressure and temperature requirements. Use high performance butterfly valves.

B. High Performance Butterfly Valves:
   1. Valves shall be as specified in Division 26, Specification Section "Valves for HVAC Piping Systems".
   2. Provide actuator and positioner. Provide limit switches as required and as indicated.
   3. Valves and actuators shall be manufactured by valve manufacturer. Valve assembly including actuator, positioner and limit switches if used shall be assembled by valve manufacturer.

C. Solenoid Valves:
1. Valves shall be brass or bronze body. Select valves to match required temperatures and pressures, and to have materials that are compatible with intended working fluids.
2. Line voltage actuators shall be Class "H" (high temperature), listed by UL or CSA.

2.3 CONTROL DAMPERS

A. General:
1. If control damper sizes are not shown or scheduled, refer to Part 1 of this Section for sizing criteria.
2. Unless otherwise indicated, modulating control dampers shall be opposed blade or parallel blade type and two (2) position (open/close) dampers shall be parallel blade type.
3. Blade linkage hardware shall have corrosion-resistant finish and be readily accessible for maintenance.
4. AMCA Leakage Classification of Control Dampers

Class	Static Pressure (Inches Water Column)			
	1	4	8	12
	Leakage Rate cfm/ft^2			
IA	3	N/A	N/A	N/A
I	4	8	11	14
II	10	20	28	35
III	40	80	112	140

B. Standard Modulating and Two (2) Position Dampers:
1. Manufacturers and acceptable model numbers:
a. Johnson Controls VD-1330 (Double Piece)
b. Honeywell D2
c. Ruskin CD50/CD60
d. Air Balance AC-525/526
e. Greenheck VCD-43/VDC-60
2. Damper frames shall be a minimum of 16 gauge galvanized steel or 14 gauge extruded aluminum. Blades shall be a minimum of 16 gauge galvanized steel or 14 gauge aluminum. Blades shall have maximum blade width of eight (8) inches with steel trunnions mounted in bronze sleeve, nylon or ball bearings.

3. Furnish dampers with blade seals and stainless steel side seals. Dampers and seals shall be suitable for maximum system temperature, pressure differential and approach velocity, but not less than temperature range of -40° to 200°F, pressure differential of six (6) inches WC, and approach velocity of four thousand (4,000) fpm based on four (4) feet damper section width.
4. Leakage rate shall meet AMCA Leakage Class IA or I.
5. Testing and ratings shall be per AMCA Standard 500-D.

2.4 DAMPER AND VALVE ACTUATORS

C. Analog Electronic:
1. Actuators shall be electric motor/gear drives that respond proportionally to analog voltage or current input, or digital floating control signals.
   a. Floating control actuators shall only be used for terminal hot water or chilled water control.
   b. Analog control actuators shall be used for all other modulating applications.
2. Stroke time for major equipment shall be ninety (90) seconds or less for 90° rotation. Stroke time for terminal equipment shall be compatible with associated local controller, but no more than six (6) minutes.
3. Provide spring return feature for fail open or closed positions, as required by control sequence, for critical applications such as outside, return, or exhaust dampers, heating and cooling coils on major air handling units, humidifiers, heat exchangers, flow control for major equipment items such as chillers, cooling towers, boilers, etc. Fail-last-position actuators do not have spring return feature.
4. Provide position feedback potentiometers connected to controller for closed loop control on major equipment analog control loops.

D. Discrete Two (2) Position Electric:
1. Actuators shall be electric motor/gear drives for two-position control. Stroke time shall be ninety (90) seconds or less for 90° rotation.
2. Provide spring return feature for fail open or closed positions as required by control sequence. Fail-last-position actuators do not have spring return feature.

E. Discrete Two (2) Position Heavy-Duty Electric:
1. Actuators shall be hydraulic or electric motor/gear drives for two-position control. Stroke time shall be ninety (90) seconds or less for 90° rotation.
2. Provide spring return feature for fail open or closed positions as required by control sequence. Fail-last-position actuators do not have spring return feature.
3. Unless otherwise indicated, actuator power shall be 120 VAC, 60 Hz, 1 Ph.

PART 3 - EXECUTION

3.1 CONTROL VALVES

A. Furnish control valves as shown on drawings and/or as required to perform control sequences specified.

B. Control valves furnished by Control Contractor shall be installed by Mechanical Contractor under coordinating control and supervision of Control Contractor.

C. Increaser and decreaser fittings required to facilitate valve installations shall be provided by Mechanical Contractor.

3.2 CONTROL DAMPERS

A. Furnish control dampers as shown on drawings and/or as required to perform control sequences specified, except those furnished with other equipment.

B. Control dampers furnished by Control Contractor shall be installed by Mechanical Contractor under coordinating control and supervision of Control Contractor.

C. Blank-off plates or transitions required to facilitate dampers shall be provided by Mechanical Contractor.

3.3 ACTUATORS AND PILOT POSITIONERS

A. Provide actuator for each automatic damper or valve with sufficient capacity to operate damper or valve under all conditions. Select actuators to provide tight shut-off against maximum system temperatures and pressure encountered. Each actuator shall be full-modulating or two-position type as required or specified, and shall be provided with spring-return for fail open or fail closed position for fire, freeze, moisture, occupant safety, equipment protection, heating or cooling system protection on power interruption as indicated and/or as required.

B. Valve and damper operating speeds shall be selected or adjusted so that actuators will remain in step with controllers without hunting, regardless of load variations. Actuators acting in sequence with other actuators shall have adjustment of control sequence as required by operating characteristics of system.

C. Provide speed control valves for “On/Off” actuators for adjustment of actuator speed to prevent water hammer or excessive stress on large valves and dampers.

D. Provide proper linkage and brackets for mounting and attaching actuators to devices. Design mounting and/or support to provide no more than 5% hysteresis in either direction (actual movement of valve stem or damper shaft versus ideal movement) due to deflection of actuator mounting.

E. Multiple damper sections shall be connected together via jackshaft or other coupling device, not by internal pinned connections at the blade shafts of individual damper sections. Where multiple damper sections are connected together via jackshaft or other coupling device, damper actuators shall be mounted directly to the jackshaft or other coupling device for operating damper sections. For instances where the damper actuator cannot be mounted to the jackshaft or other coupling device, damper actuators shall be provided for each damper section.

F. Calibrate position feedback potentiometers, where specified, with range and gain factors as required for proper operation per manufacturer's recommendations.

END OF SECTION 230902

SECTION 231101 – LEAK TEST HVAC PIPE AND DUCT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

1.2 SUMMARY

A. This section includes the requirements for leak testing of the following systems:

1. Hydronic piping (all water and glycol piping systems).
2. Refrigerant piping.
3. Supply ductwork.
4. Return air ductwork.
5. Exhaust ductwork.
6. Fresh air ductwork.

1.3 SUBMITTALS

A. General: Submit completed certified test reports for each item in this Section according to the Conditions of the Contract and Division 01 Specification Sections.

1.4 QUALITY ASSURANCE

A. Testing shall be performed by the installer of system being tested in presence of the UMB Representative.

1.5 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 PIPE SYSTEM LEAK TEST APPARATUS

A. The contractor conducting the test shall arrange for and provide all temporary services, all test apparatus, all gages, hoses and qualified personnel necessary to conduct the required testing. All leak tests shall be witnessed by UMB’s Representative. UMB requires a minimum of seven (7) days’ notice of all test procedures. Prior to scheduling

the test with UMB the contractor conducting the test shall pretest the system or segment to ensure all joints, connections etc. are leak free.

B. Test apparatus shall include a pump of appropriate size and pressure capability for all pressurized liquid systems and an oil free air compressor or gaseous nitrogen to pressurize all gaseous piping systems to the required test pressures.

C. Pressure gauges used for the test shall be in the required range and increment of the appropriate test. Gauges used for testing shall be as follows:

1. Tests requiring a pressure of 10 pounds per square inch (psi) or less shall utilize a testing gauge having increments of 0.10 psi or less.
2. Tests requiring a pressure of greater than 10 psi but less than or equal to 100 psi shall utilize a testing gauge having increments of 1 psi or less.
3. Tests requiring a pressure of greater than 100 psi shall utilize a testing gauge having increments of 2 psi or less.

D. All gauges must be set at zero before pressure is applied to the test segment.

E. Contractor conducting the test shall utilize the "UMB Standard Pipe System Leak Test Summary Form" for each pipe test to record the test results. Where multiple tests are conducted on the same pipe section a summary report of each test (pass and failed test) shall be prepared. Each summary report shall be signed by each of the parties witnessing the test. The completed reports shall be forwarded to the Construction Manager (CM). The CM or GC shall provide a copy of the reports to UMB Project Manager.

2.2 DUCT SYSTEM LEAK APPARATUS

A. The contactor conducting the test shall arrange for and provide all temporary services, all test apparatus, all temporary seals and qualified personnel necessary to conduct the required testing. All test shall be witnessed by UMB Personnel and selected test shall be witnessed by the balancing contractor. UMB requires a minimum of seven (7) days' notice for all test procedures. Prior to scheduling the test with UMB the contractor conducting the test shall pretest the system or segment to ensure all joints, connections etc. are leak free.

B. Test apparatus shall include an airflow measuring device consisting of an orifice assembly, straightening vanes and a orifice plate mounted in a straight tube, a flow producing unit consisting of a fan and an inlet damper, and pressure indicating devices consisting of a u-tube manometer (#2) across the orifice plate, a duct test pressure u-tube manometer (#1), an inclined manometer for reading orifice differential pressures below on (1) inch water gauge and accessories necessary to connect the metering system to the test specimen. The test procedure shall be as outlined in Part 3 – Execution. A copy of the certified performance curve indicating flow versus differential pressure shall be permanently attached to the test apparatus.

C. Test apparatus shall have calibration data and certificate signifying manufacturer of the meter in conformance with the ASME Requirements for Fluid Meters.

D. Orifice Plates in the test tubes shall be steel or stainless steel. Orifice openings shall be centered in the metal tube. The plates shall be flat and have holes with square edges (90 degrees) that are free of burrs. Plates shall be perpendicular to the flow path and shall be free of leaks at points of attachment.

E. Taps for static pressure indication across orifices shall be made with one sixteenth (1/16) inch to one eighth (1/8) inch diameter holes drilled neatly in the meter tube wall. The interior of the tube shall be smooth and free of projections at the drilled holes.

F. Pressure differential sensing instruments shall be readable to 0.05 inch scale division for flow rates below ten (10) cfm or 0.5 inch wg differential. For higher flow scale divisions of 0.1 inch are appropriate. U tube manometers should not be used for readings less than one (1) inch of water.

G. Liquid for manometers shall have a specific gravity of one (1) (as water) unless the scale is calibrated to read in inches of water contingent on the use of a liquid of another specific gravity, in which case the associated gage fluid must be used.

H. The duct test pressure shall be sensed only from an opening in the duct.

I. Instruments must be adjusted to zero reading before pressure is applied.

J. Contractor conducting the test shall utilize the "UMB Standard Air Duct Leak Test Summary Form" for each duct test to record the test results of each test. Where multiple tests are conducted on the same duct section a summary report of each test (pass and failed test0 shall be prepared. Each summary report shall be signed by each of the parties witnessing the test. The completed reports shall be forwarded to the Construction Manager (CM) or the General Contractor (GC). The CM or GC shall provide a copy of the reports to UMB Project Manager.

PART 3 - EXECUTION

3.1 HYDRONIC PIPING SYSTEMS

A. The Contractor conducting the test shall use this Test Procedure for Hydronic Piping systems. Test each pipe system as a whole or in segments as required by progress of the work. Perform tests prior to installation of piping insulation.

B. All Piping Systems include piping exposed and concealed above grade within the building, piping below floor slabs within the building, piping below grade five (5) feet beyond the exterior foundation wall, and/or piping above the building roof elevation and are defined as follows:

1. Hydronic Piping Systems include all Chilled Water Piping.

C. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.

D. Use vents installed at high points in the system to release trapped air while filling the system. Use drains installed at low points for complete removal of the liquid.

E. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.

F. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than one and one half (1-1/2) times the design pressure. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90% of specified minimum yield strength, or 1.7 times the "SE" value in Appendix A of ASME B31.9, Code for Pressure Piping, Building Services Piping.

G. After the hydrostatic test pressure has been applied for four (4) hours and with no allowable drop in pressure, the tested system or segment has passed the leak test. If after the four (4) hour test period there is a drop in pressure the contractor shall examine piping, joints, and connections for leakage. After the leaks have been corrected by tightening, repairing, and/or replacing components as appropriate, the hydrostatic test shall be rescheduled with UMB. The test procedure shall be repeated as specified above until there are no leaks and there is no allowable drop in pressure.

H. Test and certify that each backflow preventer has been provided in accordance with the local plumbing code and requirements of the authority having jurisdiction. Prepare and submit a certification form for each backflow preventer to the authority having jurisdiction.

3.2 REFRIGERANT PIPING SYSTEMS

A. The Contractor conducting the test shall use this Test Procedure for Refrigerant Piping Systems. Test each pipe system as a complete system. Testing this piping system in segments is not permitted. Inspect, test and perform corrective action of refrigerant piping in accordance with ASME Code B31.5, Chapter VI and as follows:

1. All refrigerant tubing shall be tested before tube insulation is applied.
2. Note: The use of compressed air for pressure testing refrigerant will not be permitted.
3. Refrigerant relief valves, if installed, shall be removed prior to pressure testing and shell openings plugged. After system is tested and found to be completely tight, relief valves shall be reinstalled prior to system evacuation.

4. Each tubing system shall be pressure tested with dry nitrogen. Leaks shall be repaired by removing and remaking the defective joint. No caulking will be permitted. After repair of leaks, system shall be retested and proved tight.
5. Tubing shall be tested at a minimum of 300 psig on the high side and 225 psig on the low side for our (4) hours. Suggested procedure is as follows:

    a. Charge system with oil pumped dry nitrogen to a pressure of 100 psig. Make a soap bubble test of all joints and all connections. Mark all leaks, blow down and repair all leaks. After the leaks have been identified and corrected by tightening, repairing, or replacing components as appropriate, the pressure test shall be rescheduled with UMB. The test procedure shall be repeated as specified until there are no leaks and the system is proved to be absolutely air tight.
    b. After above test and repair, charge high side with R-22 gas to a pressure of 30 psig. Make a rapid leak check at this pressure using an electronic leak detector. If no leaks are found, raise pressure to 300 psig on the high side and 225 psig on the low side using oil pumped dry nitrogen.
    c. Leave nitrogen and refrigerant mixture overnight to permit mixing by diffusion. Check diffusion and leak tester operation by venting a flange or valve stem. Make a thorough leak test. After the leaks have been identified and corrected by tightening, repairing, or replacing components as appropriate, the pressure test shall be rescheduled with UMB. The test procedure shall be repeated as specified until there are no leaks and the system is proved to be absolutely air tight.
    d. After the refrigerant piping has been pressure tested and proven tight, and before pipe insulation is applied, the entire system shall be evacuated with a vacuum pump to remove air and moisture. Evacuation shall be performed with all spaces containing refrigerant piping or equipment at no lower than 50°F.
    e. Manual valves except those open to atmosphere shall be opened and all controls such as solenoids shall be jacked open. Any gauges or pressure controls which could be damaged by a deep vacuum shall be valved off. Seal caps on valves shall be in place and tight. Any valves open to atmosphere shall be closed and capped.
    f. The entire system shall be double evacuated to 1,500 microns Hg absolute (1.5 torr) as follows:

        1) When vacuum pump is started, vacuum should pull down fairly rapidly to 25,000 microns Hg absolute (28.94”). If vacuum does not pull below 25,000 microns, there are leaks in the system and leak test procedure must be repeated.
        2) At approximately 10,000 microns, evaporation of free water in the system will be rapidly accelerated and vacuum will tend to remain constant as evaporation rate begins to equal vacuum pump capacity. Depending on amount of water, ambient temperature and

vacuum pump capacity, it may take several hours to make any noticeable decrease in vacuum below 10,000 microns. During this period, apply heat to any low points or suspected points of moisture. Feel pipes for cold spots and apply heat.

3) Continue evacuation until a pressure of 1,500 microns (1.5 torr) minimum is reached, then break the vacuum and pressurize to 10 psig with oil pumped dry nitrogen as a holding charge until ready for charging.

4) Before the system is ready for charging, vent nitrogen holding charge to atmosphere and re-evacuate down to a minimum of 1,500 microns to verify removal of all moisture in the piping system. Break vacuum with refrigerant gas. Do not use liquid.

3.3 AIR DISTRIBUTION DUCT SYSTEMS

A. Test each duct system as a whole or in segments as required by progress of the work. The total allowable leakage shall not exceed 1% of the total system design airflow. Use test pressure of pressure – velocity classification as follows:

1. Low Pressure Supply Duct System Test Pressure: Positive Two (2.0 inches wg.
2. Low Pressure Return and Exhaust Duct Systems Test Pressure: Negative Two (2) inches wg.

B. When testing each duct system in segments, use the following proportioning method to determine allowable losses for each segment tested:

1. ALS = (SFS/SFW) (ALW) where:

   a. ALS = Allowable Loss, Segment in Cubic Feet per Minute (CFM)
   b. ALW = Allowable Loss, Whole System in Cubic Feet per Minute (CFM) (1% of the total system design flow)
   c. SFS = Square Foot (Sq. Ft.) Surface Area, Segment of Ductwork.
   d. SFW = Square Foot (Sq. Ft.) Surface Area, of the Whole System of Ductwork.

C. Where actual leakage for a segment falls below the ALS, excess allowable may be added to another system segment.

D. Provide test blank off plates between each segment to be tested and provide access doors as specified to permit the removal of the blank off places when the testing has been completed and approved by UMB.

E. Prior to testing, the Sheet Metal Contractor shall manually remove all debris from inside ductwork, plenums, and equipment. Do not use Fans to remove the debris. Verify that all duct mounted equipment, access doors, accessories, components are installed complete as specified. Set all Fire Dampers, Smoke Dampers, or Combination

Fire/Smoke Dampers in their proper position with "Fire Links" or other devices required for operation, in place and set.

F. Pressure test all non-welded duct systems (Supply, Return, Exhaust, Fresh Air, and Relief Air) from the Primary Air Handler, Return Air or Exhaust Fan to the diffusers and grilles. All Low Pressure duct systems shall be pressure tested prior to the duct insulation being installed or the duct systems being concealed in shafts.

G. If the leakage rate of a Tested Duct System or Segment exceeds the specified allowable leakage rate then that Duct System or Segment must be inspected for leaks. Each leak shall be clearly marked and re-sealed. After the sealant has set the contractor shall reschedule the test with the appropriate contractors and UMB representatives.

H. Test Procedures shall be as follows:

1. Test for leaks as follows:

a. Close off and seal all openings in the duct section to be tested. Connect the test apparatus to the duct by means of a section of flexible duct.
b. Calculate the allowable leakage rate for the duct system or duct segment to be tested using the specified allowable leakage rate and the air volume.
c. Start the blower with its inlet control damper closed.
d. Gradually open the inlet control damper until the pressure in the duct reaches the design duct operating pressure/class. Read and record the test pressure indicated on manometer (#1). Read and record the pressure differential across the orifice indicated on manometer (#2). Read and record the duct leakage rate in CFM form the appropriate calibration curve. If there is no leakage, the pressure differential will be zero (0).
e. If the test results indicate a leakage rate that exceeds the specified leakage rate the contractor and UMB Personnel shall survey all joint for audible leaks. Mark each location and repair the joints after shutting down the blower. After the sealant has set for at least twenty four (24) to thirty six (36) hours the contractor shall reschedule the test with all appropriate parties. Follow the procedures outlined in paragraphs a, b, c and d above. If the pressure test fails again the contractor shall repeat the entire process until the tested section passes the leak test.

3.4 UMB STANDARD TEST SUMMARY FORMS

A. General: Contractors shall use the UMB Standard Forms for Recording the Leak Test Results for all Duct and Pipe Systems Tested on this Project.

1. Duct System Sample Form: See the following pages for a sample of the UMB Standard Air Duct Leak Test Summary Form.
2. Pipe System Sample From: See the following pages for a sample of the UMB Standard Pipe System Leak Test Summary Form.

3. Availability: The standard test summary forms are available on the UMB Web Site at http://www.umaryland.edu/designandconstruction/, under the Documents Link.
4. Field Testing: For field testing download and copy the forms from the UMB web site.

END OF SECTION 231101

SECTION 232113 – HVAC PIPING SYSTEMS AND SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and all other sections of Division 23.

1.2 SUMMARY

A. This section includes the requirements for HVAC pipe and specialties above ground within the building, below grade to five (5) feet outside the building and includes the following:
   1. Steel water pipe and fittings.
   2. Copper water pipe and fittings.
   3. Refrigerant pipe and fittings.
   4. Joining materials.
   5. Dielectric fittings.
   6. Air control devices.
   7. Hydronic piping specialties.
   8. Refrigerant specialties.
   9. Flexible connectors.

1.3 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, and warranty information.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

B. Suspended ceiling components.

   1. Other building services.
   2. Structural members.

C. Qualification Data: For Installer.

D. Welding certificates.

E. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
2. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

E. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

F. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

G. ASME Compliance: Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

1.7 FIELD CONDITIONS

A. Interruption of Existing HVAC Systems: Interruption of HAVC systems in facilities occupied by Owner or others shall not be permitted unless approved by CM and UMB – PM. under the following conditions and then only after arranging to provide temporary HVAC services according to requirements indicated:

1. Notify the Construction Manager and the no fewer than five (5) days in advance of proposed interruption of the HVAC systems.
2. Do not interrupt HVAC services without Construction Manager's written permission.

1.8 WARRANTY/GUARANTEE

A. See Division 23, Specification Section "Basic Mechanical Requirements – HVAC" for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Material Design and Selection: HVAC water pipe, fittings, and specialties shall be designed and selected, for the intended use, in accordance with the sizes on the drawings and the requirements of this specification.

B. Acceptable Manufacturers: Acceptable manufacturers shall be as follows:

1. Steel Piping Systems: All steel pipe and fittings shall be by one (1) manufacturer.

a. Pipe: Mueller Industries, Wheatland Tube Company.
b. Grooved Pipe: Victaulic.
c. Fittings: Anvil, Victaulic.

2. Copper Tube Piping Systems:

a. Solder Joint Copper Tube and Fittings: All copper tube and/or fittings for solder joint application shall be by one manufacturer.

1) Mueller Industries

b. Press Type Copper Piping Systems: The basis of design is Viega ProPress copper piping system. Other acceptable manufacturers are:

1) Nibco Inc.
2) Elkhart Products Corporation – Apollo XPress.

3. Dielectric Fittings:

a. Unions: Watts, Zurn and Capitol Manufacturing Company.
b. Flanges: Watts, Zurn and Capitol Manufacturing Company.
c. Insulating Kits: Pipeline Seal and Insulator Company, Calpico, Inc.
d. Nipples: Victaulic, Precision Plumbing Products, Inc. and Elster Perfection

4. Air Control Devices:

   a. Manual Air Vents: Armstrong, Bell and Gossett, Hoffman.
   b. Automatic Air Vents: Armstrong, Bell and Gossett, Hoffman.

5. Hydronic Specialties:

   a. Y Strainers: Mueller, Spirax Sarco, Hoffman, and Armstrong.
   b. Basket Strainers: Mueller, Spirax Sarco, Hoffman, and Armstrong.

6. Flexible Connectors: Metraflex Corporation or approved equal

2.2 HVAC PIPE MATERIAL APPLICATION

A. General Application: All pipe, fittings and joint methods shall be as specified below:

B. HVAC Pipe Material Application Schedule:

Pipe System	Pipe Material	Fitting Material	Joint Material
Chilled Water (Inside BLDG)	Copper Tube: ASTM B88, Type 'L', Seamless, Water Tube, hard drawn temper	2" and Smaller: Copper Tube: ASTME B16.22, wrought copper or copper alloy solder joint, 150 lb.	2" and Smaller: ASTM B32, alloy Sb5 (95 percent tin, and 5 percent antimony), with 0.2 percent maximum lead content
		1/2 inch to 2 inch Viega ProPress copper fittings with EPDM seals. (Contractor Option)	Press connection with EPDM sealing element. (Contractor Option)
	2-1/2" and Larger: Steel Pipe: ASTM A53, Grade B, Schedule 40, black steel	2-1/2" and Larger: Steel; ASTM A234, butt welded, long radius ells, and weld o lets. Flanges: ANSI B 16.5, weld neck, raised faced with gaskets.	2-1/2" and Larger: Welded: Latest revision of Section IX, ASME Boiler Pressure Vessel Code, Filler material per AWS D10.12.
Chilled Water	Pipe: 2-1/2" to 12": Victaulic rolled grooved end schedule 40 black steel pipe, 150 lb. ANSI Class, ASTM F-1476 by	Fittings: Ductile Iron Grooved End Fittings for Elbows, Tees, Increasers, Reducers, 'Y' Fittings, conforming	Joints: Vic Style 07 Zero - Flex Rigid Ductile Iron couplings with Grade 'E' EPDM

	Victaulic Corp. USA. (Contractors Option)	to ASTM A - 395, grade 65-45-15 (Contractors Option)	gasket material, Carbon Steel Nuts and Bolts, conforming to ASTM A-395, Grade 65-45-15, ASTM A - 183. Vic Flange Adapters: Vic Style 743, Ductile Iron, conforming to ASTM A -536, grade 65-45-12. (Contractors Option)

Pipe System	Pipe Material	Fitting Material	Joint Material
Air Conditioning Condensate and Equipment Drains	Copper Drainage Tube; DWV, ASTM B306	Wrought copper and Bronze drainage fittings, ASNI B16.29	ASTM B32, alloy Sb5 (95 percent tin, and 5 percent antimony), with 0.2 percent maximum lead content
Refrigerant Piping System	Copper Tube: ASTM B280, 'ACR' Type 'L', Seamless, hard drawn soft annealed seamless, factory cleaned and capped prior to shipping.	ASNI B16.22, wrought copper fittings.	Brazed: AWS A5.8, Classification BCuP-3 Brazed (Silver) filler material.

2.3 COPPER TUBE FITTINGS

A. Grooved, Mechanical-Joint, Wrought-Copper Fittings: ASME B16.22.

1. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
2. Grooved-End-Tube Couplings: Rigid pattern unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, EPDM gasket rated for minimum 230°F for use with housing, and steel bolts and nuts.

B. Copper or Bronze Pressure-Seal Fittings:

C. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube.

D. Wrought-Copper Unions: ASME B16.22.

2.4 STEEL PIPE FITTINGS

A. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.

B. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

C. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.

D. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

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

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

F. Grooved Mechanical-Joint Fittings and Couplings:

1. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106/A 106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
2. Couplings: Ductile- or malleable-iron housing and EPDM gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

G. Steel Pressure-Seal Fittings:

1. Housing: Steel.
2. O-Rings and Pipe Stop: EPDM.
3. Tools: Manufacturer's special tool.
4. Minimum 300-psig working-pressure rating at 230°F.

H. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.5 JOINING MATERIALS

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

1. ASME B16.21, nonmetallic, flat, asbestos free, one eighth (1/8) inch maximum thickness unless otherwise indicated.

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

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

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

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

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Description:

a. Standard: ASSE 1079.
b. Revise pressure rating in "Pressure Rating" Subparagraph below to suit Project, or insert other options for specific applications.
c. Pressure Rating: 125 psig minimum at 180°F .
d. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Description:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.

c. Pressure Rating: 125 psig minimum at 180°F.
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Description:

a. Standard: IAPMO PS 66.
b. Electroplated steel nipple, complying with ASTM F 1545.
c. Pressure Rating: 300 psig at 225°F.
d. End Connections: Male threaded or grooved.
e. Lining: Inert and noncorrosive, propylene.

2.7 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225°F.

B. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240°F.

C. Air Purgers:

1. Body: Cast iron with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal.
2. Maximum Working Pressure: 150 psig.
3. Maximum Operating Temperature: 250°F.

2.8 HYDRONIC PIPING SPECIALTIES

A. Pipe Flange Gasket Materials - Not Steam Systems: Suitable for the chemical and thermal conditions of the piping system contents:

1. ASME B16.21, nonmetallic, flat, asbestos free, one eighth (1/8) inch (3mm) maximum thickness, except where thickness or specific material is indicated.

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

2. ASME B16.20 for grooved, ring-joint, steel flanges.
3. AWWA C110, rubber, flat face one eighth (1/8) inch (3 mm) thick, except where other thickness are indicated, and full-face or ring type, except where type is indicated.

B. Flange Bolts and Nuts:

1. Non-Steam Systems: ASME B18.2.1, carbon steel, except where other material is indicated.
2. Steam Systems: ASTM A193, B7, Hex Head Bolts; ASTM A194, 2H, Hex Nuts.

C. Unions: ANSI B16.39, Class 150, malleable iron; female pattern; brass to iron seat; ground joint. Threads shall conform to ANSI B1.20.1.

D. Y-Pattern Strainers:

1. Non-Steam and Condensate (Copper Piping two (2) inch and smaller)

a. Basis-of-Design Product: Subject to compliance with requirements, provide Mueller Model 352M or comparable product by one (1) of the acceptable manufacturers.
b. Body: ASTM A 126, Class B, cast bronze body with bolted cover and bottom drain connection.
c. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
d. Strainer Screen: 304 Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket.
e. CWP Rating: 125 psig.

f. Blow-down drain with plugged valve and threaded hose connection

2. Non-Steam and Condensate (Copper Piping two and one half (2-1/2) inch and larger)

a. Basis-of-Design Product: Subject to compliance with requirements, provide Mueller Model 758, or comparable product by one (1) of the acceptable manufacturers.
b. Body: ASTM A 126, Class B, cast iron body with bolted cover and bottom drain connection.
c. End Connections: Flanged ends for NPS 2-1/2 and larger.
d. Strainer Screen: 304 Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket. Screens for four (4) inch strainers shall have .062 size perforated openings. Screen for five (5) inch and larger strainers shall have .125 perforated openings.
e. Blow-down drain with plugged valve and threaded hose connection
f. CWP Rating: 200 psig.

3. Non-Steam and Condensate (Steel Piping two and one half (2-1/2) inch and larger)

a. Basis-of-Design Product: Subject to compliance with requirements, provide Mueller Model 758, or comparable product by one (1) of the acceptable manufacturers.
b. Body: ASTM A 126, Class B, cast iron body with bolted cover and bottom drain connection.
c. End Connections: Flanged ends for NPS 2-1/2 and larger.
d. Strainer Screen: 304 Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket. Screens for four (4) inch strainers shall have .062 size perforated openings. Screen for five (5) inch and larger strainers shall have .125 perforated openings.
e. Blow-down drain with plugged valve and threaded hose connection
f. CWP Rating: 200 psig.

E. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: flanged ends for NPS 2-1/2.
3. Strainer Screen: 40-mesh startup strainer, and perforated 304 stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.
5. Blow-down drain with plugged valve and threaded hose connection

F. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250°F.

G. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250°F.

H. Diverting Fittings: cast iron body with threaded ends, or wrought copper with solder ends; 125 psig working pressure, 250ºF maximum operating temperature. Indicate flow direction on fitting.

2.9 REFRIGERANT SYSTEM SPECIALTIES

A. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275°F.

B. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240°F.

C. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.

2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Retain first subparagraph below for heat pumps.
5. Designed for reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Retain first subparagraph below for suction-line filter dryers.
8. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
9. Maximum Pressure Loss: 2 psig.
10. Rated Flow: <Insert tons.>
11. Working Pressure Rating: 500 psig.
12. Maximum Operating Temperature: 240°F.

D. Permanent Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Retain first subparagraph below for heat pumps.
5. Designed for reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Retain first subparagraph below for suction-line filter dryers.
8. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
9. Maximum Pressure Loss: 2 psig.
10. Rated Flow: <Insert tons.>
11. Working Pressure Rating: 500 psig.
12. Maximum Operating Temperature: 240°F.

2.10 FLEXIBLE CONNECTORS

A. Stainless-Steel Bellows, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of three quarter (3/4) inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250°F.

PART 3 - EXECUTION

3.1 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

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

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

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

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

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

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

P. Install valves according to Division 23 Specification Section "Valves for HVAC Piping Systems."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

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

S. Install shutoff valve immediately upstream of each dielectric fitting.

T. Comply with requirements in Division 23 Specification Section "Identification for HVAC Piping and Equipment" for identifying piping.

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Specification Section "Sleeve, Sleeve Seals and Escutcheons for HVAC Piping."

V. Retain first paragraph below for piping that penetrates an exterior concrete wall or concrete slab.

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Specification Section "Sleeve, Sleeve Seals and Escutcheons for HVAC Piping."

3.2 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits, or nipples.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.3 HANGERS AND SUPPORTS

A. Comply with requirements in Section "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

B. Comply with requirements in Division 23 Specification Section "Vibration and Seismic Controls for HVAC" for seismic restraints.

3.4 PIPE JOINT CONSTRUCTION

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

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

C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

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

H. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

I. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.5 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with a ball valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gauges and thermometers at coil inlet and outlet connections. Comply with requirements in Division 23 Specification Section "Meters and Gauges for HVAC Piping."

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

3.7 EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install vacuum breakers downstream from control valve, close to coil inlet connection.

E. Install a drip leg at coil outlet.

3.8 REFRIGERANT SPECIALTY APPLICATIONS

A. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

B. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

1. Edit list below for equipment required for Project.
2. Solenoid valves.
3. Thermostatic expansion valves.
4. Hot-gas bypass valves.
5. Compressor.

C. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

D. Consult refrigeration equipment manufacturer to determine the need for a receiver.

E. Install receivers sized to accommodate pump-down charge.

F. Install flexible connectors at compressors.

3.9 PIPE JOINT CONSTRUCTION

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

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

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

F. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.

H. Welded Joints: Construct joints according to AWS D10.12/D10.12M.

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

3.10 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high and low pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in process cooling water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

3.11 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
4. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least ten (10) minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

3.12 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris; repair damaged finishes, including chips, scratches, and abrasions.

B. Before adding chemicals to the system, isolate coils of heating and cooling equipment, and open bypasses.

C. Flushing portions of the system:

1. After a piping loop has been completed and prior to the installation of strainer baskets, flush that portion of the system. Connections shall be same size as piping being flushed, or one size smaller.
2. When a major section of the building has been completed, repeat the same procedure, except that pipe connections shall be limited to 1.5 inch.
3. Flushing shall remove sediment, scale, rust and other foreign substances.
4. After flushing, install strainers and pressure test system and make it tight.

D. Flushing building system: After the various portions of the piping system have been tested and flushed and system is substantially completed, fill the system completely with water, venting all trapped air, and operating the pump.

1. Open a drain at the low point of the system while replacing the water through the make-up at the same rate.
2. Continue flushing until clean water shows at the drain, but for not less than two hours.

3. After flushing, remove strainers and clean and replace them. Remove the bypass around the equipment and install control valves.

E. Chemical cleaning: Fill system with sufficient detergent and dispersant to remove dirt, oil, and grease.

1. Circulate for at least forty eight (48) hours.
2. Open a drain valve at the lowest point and bleed while the system continues to circulate. Assure that the automatic make-up valve is operating.
3. Continue until water runs clear and all chemicals are removed. Sample and test the water until pH is the same as pH of makeup water.
4. After chemical cleaning, remove strainers, clean and reinstall them.
5. Close bypasses and open valves to coils.

F. Submit certificate and test results.

END OF SECTION 232113

SECTION 233113 – HVAC DUCT SYSTEMS AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

1.2 SUMMARY

A. This section includes the requirements for HVAC Duct Systems and related accessories as follows:

1. Sheet metal materials.
2. Sealants and gaskets.
3. Single-wall rectangular ducts and fittings.
4. Hangers and supports.
5. Backdraft dampers.
6. Manual volume dampers.
7. Fire dampers.
8. Smoke dampers.
9. Combination fire and smoke dampers.
10. Duct-mounted access doors.
11. Flexible connectors.
12. Flexible ducts

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, wirings diagrams, power requirements, specified options, and warranty information.

B. For each type of the following products:

1. Construction details for ductwork and fittings.
2. Adhesives.
3. Sealants and gaskets.

C. Shop Drawings:

1. Factory- and shop-fabricated ducts and fittings.
2. Duct static-pressure classes.
3. Seam and joint construction.
4. Duct accessories, including dampers, turning vanes, and access doors and panels.
5. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTAL

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

1.7 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

1.8 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Material Design and Selection: HVAC Duct Systems and Accessories shall be designed and selected, for the intended use, in accordance with the sizes on the drawings and the requirements of this specification.

2.2 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

E. Tie Rods: Galvanized steel, one quarter (1/4) inch minimum diameter for lengths thirty six (36) inches or less; three eights (3/8) inch minimum diameter for lengths longer than thirty six (36) inches.

2.3 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of twenty five (25) and a maximum smoke-developed index of fifty (50) when tested according to UL 723; certified by an NRTL.

B. Two (2) Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: Three (3) inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: Ten (10) inch wg. positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: - 40°F to +200°F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65%.
3. Shore A Hardness: Minimum Twenty (20).
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: Ten (10) inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: Twenty five (25).
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile

Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of three (3) cfm/100 sq. ft. at one (10) inch wg. and shall be rated for ten (10) inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

G. Duct Connection Joint Sealant: For renovation projects where new ductwork connects to existing ductwork provide the following material as a joint sealer between the new and existing duct surfaces:

1. Permatite, Butyl gray non curing tape of sufficient width to seal the duct joints. Material can be purchased from the manufacturer or from Grainger using the either the manufacturers model number DS5285, or the Grainger item number 2EJR3. Seal the external joints as required by these specifications and the ductwork can be placed in service.

2.4 SINGLE WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure

class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are nineteen (19) inches and larger and are 20 gauge or less, with more than ten (10) sq. ft. of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standard," Figure 1-4, unless they are lined or are externally insulated.

2.5 SINGLE WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Lindab Inc.
b. McGill AirFlow LLC.
c. SEMCO Incorporated.
d. Sheet Metal Connectors, Inc.
e. Spiral Manufacturing Co., Inc.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than sixty (60) Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than ninety (90) inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than seventy two (72) inches in width (major dimension) with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements,

materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Elbows: Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate the bend radius of die-formed, gored, and pleated elbows one and one half (1.5) times the elbow diameter. Unless elbow construction type is indicated, provide elbows meeting the following requirements:

F. Mitered Elbows: Fabricate mitered elbows with welded construction in gauges specified below:

1. Mitered Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with SMACNA "HVAC Duct Construction Standards," Table 3-1.
2. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from minus two (2) inches to plus two (2) inches:

    a. Three (3) inches to twenty six (26) inches: 24 gauge.
    b. Twenty seven (27) inches to thirty six (36) inches: 22 gauge.
    c. Thirty seven (37) inches to fifty (50) inches: 20 gauge.
    d. Fifty two (52) inches to sixty (60) inches: 18 gauge.
    e. Sixty two (62) inches to eighty four (84) inches: 16 gauge.

G. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from two (2) inches to ten (10) inches:

1. Three (3) inches to fourteen (14) inches: 24 gauge.
2. Fifteen (15) inches to twenty six (26) inches: 22 gauge.
3. Twenty seven (27) inches to fifty (50) inches: 20 gauge.
4. Fifty two (52) inches to sixty (60) inches: 18 gauge.
5. Sixty two (62) inches to eighty four (84) inches: 16 gauge.

H. 90-Degree, Two (2) Piece, Mitered Elbows: Use only for supply systems, or exhaust systems for material handling classes A and B, and only where space restrictions do not permit the use of one and one half (1.5) bend radius elbows. Fabricate with a single-thickness turning vanes.

I. Round Elbows – Eight (8) Inches and Smaller: Die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend angle configurations or one half (1/2) inch-diameter (e.g. 3-1/2- and 4-1/2-inch) elbows with gored construction.

J. Round Elbows – Nine (9) Inches Through Fourteen (14) Inches: Gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 9-1/2- and 10-1/2-inch) elbows with gored construction.

K. Round Elbows - Larger Than Fourteen (14) Inches and All Flat Oval Elbows: Gored elbows, except where space restrictions require a mitered elbow.

L. Die-Formed Elbows for Sizes through Eight (8) Inches and All Pressures: 20 gauge with two (2) piece welded construction.

M. Round Gored Elbows Gages: Same as for nonelbow fittings specified above.

N. Pleated Elbows Sizes through Fourteen (14) Inches and Pressures through Ten (10) Inches: 26 gauge.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.7 BACKDRAFT DAMPERS

A. Light to Medium Duty (1,000 to 1,500 FPM maximum velocity)

1. Basis-of-Design Product: Subject to compliance with requirements, Ruskin BD2/A1 and Ruskin BD2/A2 or comparable product by one (1) of the following:

a. American Warming and Ventilating; a division of Mestek, Inc.
b. Greenheck Fan Corporation.
c. Ruskin Company.

2. Description: Gravity balanced.
3. Operation Pressure: BD2A1 blades open at 0.03 in. wg. and are fully open at 0.10 inch wg. BD2A2 blades open at 0.10 inch wg. and are fully open at 0.15 inch w.g.
4. Frame: Hat-shaped, 0.090-inch-thick extruded aluminum, with mitered corners.
5. Blades: (1000 FPM maximum velocity) -. Ruskin BD2/A1, 0.025 inch formed aluminum, extruded vinyl edge seals. (1,500 FPM maximum velocity) - Ruskin BD2/A2, 6063T5 extruded aluminum, 0.050 inch wall thickness, extruded vinyl edge seals.
6. Blade Action: Parallel.
7. Blade Seals: Extruded vinyl, mechanically locked.
8. Blade Axles:

a. Material: Nonferrous metal.
b. Diameter: 0.20 inch.

9. Return Spring: Adjustable tension.
10. Bearings: synthetic pivot bushings.
11. Accessories:

a. Electric actuators.
b. Screen Mounting: Rear mounted.
c. Screen Material: Galvanized steel.
d. Screen Type: Bird.

B. Heavy Duty Backdraft Dampers (1,500 to 2,500 FPM maximum velocity)

1. Basis-of-Design Product: Subject to compliance with requirements, Ruskin BDG or comparable product by one (1) of the following:

a. American Warming and Ventilating; a division of Mestek, Inc.
b. Greenheck Fan Corporation.
c. Ruskin Company.

2. Description: Gravity balanced.
3. Operation Pressure: Blades open at 0.12 inch wg. And are fully open at .20 inch wg.
4. Frame: Hat-shaped, 0.0125-inch-thick extruded aluminum, with galvanized steel braced corners.
5. Blades: Extruded aluminum 0.070 inch wall thickness.
6. Blade Action: Parallel.
7. Blade Seals: Extruded vinyl mechanically locked.
8. Blade Axles:

a. Material: Nonferrous metal.
b. Diameter: 0.20 inch.

9. Tie Bars and Brackets: Aluminum.
10. Return Spring: Adjustable tension.
11. Bearings: synthetic pivot bushings.
12. Accessories:

a. Electric actuators.
b. Adjustable static pressure control.
c. Screen Mounting: Rear mounted.
d. Screen Material: Galvanized steel.
e. Screen Type: Bird.

C. Counterbalanced Backdraft Dampers

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ruskin CBD2 or comparable product by one (1) of the following:

a. American Warming and Ventilating; a division of Mestek, Inc.
b. Greenheck Fan Corporation.
c. Ruskin Company.

D. Description: Gravity balanced.

E. Maximum System Pressure: Max0.04 inch wg. at 1,000 feet per minute

F. Frame: Hat-shaped, 0.090-inch- thick, extruded aluminum, with welded corners or mechanically attached and mounting flange.

G. Blades: Multiple single-piece blades, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum with sealed edges.

H. Blade Action: Parallel.

I. Blade Seals: Extruded vinyl, mechanically locked.

J. Blade Axles:

1. Material: Synthetic
2. Diameter: 0.20 inch.

K. Tie Bars and Brackets: Aluminum.

L. Return Spring: Adjustable tension.

M. Bearings: synthetic pivot bushings.

N. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.

2.8 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ruskin Model No. CD36 or comparable product by one (1) of the following:

   a. American Warming and Ventilating; a division of Mestek, Inc.
   b. Greenheck Corporation.
   c. Ruskin Company.

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:

   a. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

   a. Multiple blade with three longitudinal grooves for reinforcement.
   b. Parallel or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized-steel, 0.064 inch thick.

6. Blade Axles: Galvanized steel.
7. Bearings:

   a. Molded synthetic.
   b. Dampers in ducts with pressure classes of three (3) inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

B. Low-Leakage, Steel, Manual Volume Dampers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ruskin Model No. CD60 or comparable product by one (1) of the following:

   a. American Warming and Ventilating; a division of Mestek, Inc.
   b. Greenheck Corporation.
   c. Ruskin Company.

2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames:

    a. Hat shaped.
    b. 0.094-inch-thick, galvanized sheet steel.
    c. Mitered and welded corners.
    d. Flanges for attaching to walls and flangeless frames for installing in ducts.

6. Blades:

    a. Multiple blade six (6) inch wide.
    b. Parallel or opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Galvanized, roll-formed steel, 0.064 inch thick.

7. Blade Axles: Galvanized steel.
8. Bearings:

    a. Molded synthetic.
    b. Dampers in ducts with pressure classes of three (3) inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

9. Blade Seals: Neoprene.
10. Jamb Seals: Cambered stainless steel.
11. Tie Bars and Brackets: Galvanized steel.
12. Accessories:

    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

C. Low-Leakage, Aluminum, Manual Volume Dampers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ruskin Model CD50 or comparable product by one (1) of the following:

    a. American Warming and Ventilating; a division of Mestek, Inc.
    b. Greenheck Corporation.
    c. Ruskin Company.

2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.

5. Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
6. Blades:

    a. Multiple 6 inch wide.
    b. Parallel- or opposed-blade design.
    c. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
    d. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.

7. Blade Axles: Galvanized steel.
8. Bearings:

    a. Molded synthetic.
    b. Dampers in ducts with pressure classes of three (3) inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

9. Blade Seals: Neoprene, replaceable.
10. Jamb Seals: Cambered stainless steel.
11. Tie Bars and Brackets: Galvanized steel.
12. Accessories:

    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

D. Jackshaft:

1. Size: 0.5-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

E. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of three thirty second (3/32) inch- thick zinc-plated steel, and a three quarter (3/4) inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.9 FIRE DAMPERS

A. Static Type Fire Damper:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ruskin IBDD2 or comparable product by one (1) of the following:

a. Air Balance Inc.; a division of Mestek, Inc.
b. Ruskin Company.
c. United Sheet Metal.

2. Type: Rated and labeled according to UL 555 by an NRTL.
3. Closing rating in ducts up to four (4) inch wg static pressure class and minimum 2000-fpm velocity.
4. Fire Rating: One and one half (1-1/2) hours.
5. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, four and seven eighth (4-7/8) inches wide, 20 gauge galvanized steel channel complete with integral 20 gauge galvanized steel sleeve with twelve (12) inch, fourteen (14) inch, or sixteen (16) inch length as required to suit wall construction. Sleeve may be omitted if wall thickness matches damper construction per UL 555.
6. Mounting Orientation: Vertical or horizontal as indicated.
7. Blades: Roll-formed, interlocking, 0.024-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
8. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
9. Heat-Responsive Device: Replaceable, 165°F rated, fusible links.

B. Dynamic Type Fire Damper:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ruskin DIBD2 or comparable product by one (1) of the following:

a. Air Balance Inc.; a division of Mestek, Inc.
b. Ruskin Company.
c. United Sheet Metal.

2. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
3. Closing rating in ducts up to four (4) inch wg static pressure class and minimum 2,000-fpm velocity.
4. Fire Rating: One and one half (1-1/2) hours.
5. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, four and seven eight (4-7/8) inches wide, 20 gauge galvanized steel channel complete with integral 20 gauge galvanized steel sleeve with twelve (12) inch, fourteen (14) inch, or sixteen (16) inch length as required to suit wall construction. Sleeve may be omitted if wall thickness matches damper construction per UL 555.
6. Mounting Orientation: Vertical or horizontal as indicated.
7. Blades: Roll-formed, interlocking, 0.024-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
8. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
9. Heat-Responsive Device: Replaceable, 165°F rated, fusible links.

2.10 SMOKE DAMPERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Ruskin SDRS25 and SDS60 for round and square multiple blade models or comparable product by one (1) of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Ruskin Company.
3. United Sheet Metal.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Smoke Detector: Integral, factory wired for single-point connection.

D. Frame: Hat-shaped, 16 gauge, galvanized sheet steel, with welded or mechanically attached corners and mounting flange.

E. Blades: two (2) piece 14 gauge (round), one piece airfoil (square), thick, galvanized sheet steel.

F. Leakage: Class I.

G. Rated pressure and velocity: Four (4) inch wg. in the closed position and 3,500 FPM in the open position.

H. Blade Seals: Silicone edge type, mechanical fastened to the blade edge, for smoke seal to 450°F.

I. Bearings: Stainless steel, sleeve type.

J. Mounting Sleeve: Factory-installed, 0.05-inch- thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

K. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Specification Section "Motor Requirements for HVAC Equipment."

L. Accessories:

1. Auxiliary switches for signaling fan control or position indication.
2. Test and reset switches, damper mounted.

2.11 COMBINATION FIRE AND SMOKE DAMPERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Ruskin FSD60, FSD60-2, FSD60-3 or comparable product by one (1) of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Ruskin Company.
3. United Sheet Metal.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to four (4) inch wg static pressure class and minimum 2,000-fpm velocity.

D. Fire Rating: One and one half (1-1/2) hours.

E. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel.

F. Heat-Responsive Device: Resettable, 165°F rated.

G. Actuator: Electric or pneumatic - actuator shall be specified and provided under Division 23 Specification Sections for the "Building Automation Systems" for factory mounting during smoke damper fabrication. Each damper shall be provided with a blade position indicator linked directly to the damper blade to remotely indicate damper position to the ATC/Fire alarm system as required under system operating sequences or as indicated Damper and actuator shall be successfully factory cycled ten (10) times. Each assembly shall be equipped with a controlled seven (7) to fifteen (15) second heat actuated release device allowing the damper to close and lock during test, smoke detection, power failure or fire conditions. Dampers shall be capable of automatic remote reset.

H. Smoke Detector: Integral, factory wired for single-point connection.

I. Vertical blades are available for special applications.

J. Blades: One piece air foil, 16 gauge, galvanized sheet steel.

K. Leakage: Class I.

L. Rated pressure and velocity to exceed design airflow conditions.

M. Mounting Sleeve: Factory-installed, 0.039-inch thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

N. Master control panel for use in dynamic smoke-management systems.

O. Damper Motors: Two (2) position action.

P. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section "Common Motor Requirements for HVAC Equipment."

Q. Accessories:

1. Auxiliary switches for signaling fan control or position indication.
2. Test and reset switches, damper mounted.

2.12 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements provide products by one (1) of the following:

1. Air Balance, Inc.
2. Ruskin.
3. United Sheet Metal

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

a. 22 gauge, double wall, rectangular.
b. Galvanized sheet metal with 1 inch thick fiberglass insulation.
c. Hinges and Latches: Continuous piano hinge and cam latches.
d. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

2.13 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements products by one (1) of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip three and one half (3-1/2) inches wide attached to two (2) strips of two and three quarter (2-3/4) inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.

3. Service Temperature: - 40°F to + 200°F.

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd.
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: - 50°F to + 250°F.

2.14 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements provide products by one (1) of the following:

1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.

1. Pressure Rating: four (4) inch wg. positive and 0.5-inch wg. negative.
2. Maximum Air Velocity: 4,000 fpm.
3. Temperature Range: - 20°F to + 175°F.
4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1.

C. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes three (3) inches through eighteen (18) inches, to suit duct size.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of one (1) inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least one and one half (1-1/2) inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or No. 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than four (4) inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than four (4) inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within twenty four (24) inches of each elbow and within forty eight (48) inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of sixteen (16) feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Architectural Specification Sections "Exterior Painting" and/or "Interior Painting."

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:
    a. Supply Ducts with a Pressure Class of Two (2) Inch wg. or Higher: Test representative duct sections totaling no less than percent of total installed duct area for each designated pressure class.
    b. Return Ducts with a Pressure Class of Two (2) Inch wg. or Higher: Test representative duct sections totaling no less than 50% of total installed duct area for each designated pressure class.
    c. Exhaust Ducts with a Pressure Class of Two (2) Inch wg. or Higher: Test representative duct sections totaling no less than 50% of total installed duct area for each designated pressure class.
3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.8 START UP

A. Air Balance: Comply with requirements in Division 23 Specification Section "Testing, Adjusting, and Balancing HVAC Systems."

3.9 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Supply Ducts:

1. Pressure Class: Positive three (3) inch wg.
2. Minimum SMACNA Seal Class: A.
3. SMACNA Leakage Class for Rectangular: 6.
4. SMACNA Leakage Class for Round and Flat Oval: 3.

C. Return Ducts:

1. Pressure Class: Positive or negative two (2) inch wg.
2. Minimum SMACNA Seal Class: B.
3. SMACNA Leakage Class for Rectangular: 12.
4. SMACNA Leakage Class for Round and Flat Oval: 6.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

a. Pressure Class: Negative two (2) wg.
b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Pressure Class: Positive or negative two (2) wg.
2. Minimum SMACNA Seal Class: B.
3. SMACNA Leakage Class for Rectangular: 12.
4. SMACNA Leakage Class for Round and Flat Oval: 6.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

2. Stainless-Steel Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Match duct material.

3. Aluminum Ducts: Aluminum.

G. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1,000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1,000 to 1,500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1,500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1,000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1,000 to 1,500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1,500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, twelve (12) Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, fourteen (14) Inches and Larger in Diameter: Standing seam.

H. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1,000 fpm or Lower: 90-degree tap.
b. Velocity 1,000 to 1500 fpm: Conical tap.
c. Velocity 1,500 fpm or Higher: 45-degree lateral.

3.10 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum fifty (50) foot spacing.
8. Upstream from turning vanes.
9. Upstream or downstream from duct silencers.
10. Control devices requiring inspection.
11. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Access Door Sizes:

1. One-Hand or Inspection Access: Eight (8) inches by five (5) inches.
2. Two-Hand Access: Twelve (12) inches by six (6) inches.
3. Head and Hand Access: Eighteen (18) inches by ten (10) inches.
4. Head and Shoulders Access: twenty one (21) inches by fourteen (14) inches.
5. Body Access: Twenty five (25) inches by fourteen (14) inches.
6. Body plus Ladder Access: Twenty five (25) inches by seventeen (17) inches.

K. Label access doors according to Division 23 Specification Section "Identification for HVAC Systems and Equipment" to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment.

M. Connect equipment to supply ducts with maximum six (6) inch lengths of flexible duct. Do not use flexible ducts to change directions.

N. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

O. Install duct test holes where required for testing and balancing purposes.

P. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of one quarter (1/4) inch movement during start and stop of fans.

3.11 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233113

SECTION 233423 – HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

1.2 SUMMARY

A. This section includes the requirements for centrifugal exhaust fans and power ventilators and accessories as follows:

1. Miscellaneous exhaust fans – Propeller and ceiling fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan performance ratings on actual project site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

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

1. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:

a. Certified fan performance curves with system operating conditions indicated.
b. Certified fan sound power ratings.
c. Motor ratings and electrical characteristics, plus motor and electrical accessories.
d. Material thickness and finishes, including color charts.
e. Dampers, including housings, linkages, and operators.
f. Fan speed controllers.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans 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. Roof framing and support members relative to duct penetrations.
2. Ceiling suspension assembly members.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

B. Maintenance Material Submittals:

1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
2. Belts: One (1) set(s) for each belt driven unit.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.8 SOURCE QUALITY CONTROL

A. Certify sound power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA Certified Ratings Seal.

1.9 COORDINATION

A. Coordinate size and location of structural steel support members.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of equipment supports, and roof penetrations with actual equipment provided.

1.10 WARRANTY/GUARENTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Exhaust air fans and power ventilators shall be designed and selected in accordance with the scheduled capacities on the drawings and the requirements of this specification. All fans shall bear the AMCA Seal, and fan ratings shall be based on test and procedures performed in accordance with AMCA Publication 211, AMCA Publication 311 and comply with the AMCA Certified Ratings Program and be UL and/or CUL listed.

B. Basis of Design: The basis of design for exhaust air fans and power ventilators shall be equipment manufactured by Twin City Fans as follows:

1. Miscellaneous Centrifugal Fans:
   a. Ceiling Mounted Fans – T Series
   b. Propeller Fans - WPD

C. Other Acceptable Manufacturers: Subject to compliance with requirements, provide exhaust air fans and power ventilators by one (1) of the following:
1. Miscellaneous Centrifugal Fans:

a. Propeller Fans: Greenheck, New York City Blower, Loren Cook, ACME
b. Ceiling Mounted Fans: Greenheck, New York City Blower, Loren Cook, ACME

D. Factory Run Test: Prior to shipment all fans shall be completely assembled and test run as a unit at operating speed or maximum RPM allowed for the particular construction type. Each wheel shall be statically and dynamically balanced in accordance with ANSI/AMCA 204-96 "Balance Quality and Vibration Levels for Fans" to Fan Application Category BV-3, Balance Quality Grade G6.3. Balance readings shall be taken by electronic type equipment in the axial, vertical and horizontal directions on each of the bearings. Records shall be maintained and a written copy shall be available upon request.

E. Motors: Motors shall comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Specification Section "Motor Requirements for HVAC Equipment."

2.2 MISCELLANOUS FANS

A. Propeller Fans: Propeller fans shall comply with the following:

1. Propeller Wall Fans: Medium duty direct-driven propeller wall fans for general-purpose ventilation.
2. Fan Capacities and characteristics: Refer to Drawing schedule.
3. Propeller: Painted steel blades welded to steel hub. Hub secured to motor shaft with tapered bushing.
   a. Statically and dynamically balance propeller.

4. Motors: Comply with NEMA MG-1 for designation, temperature rating, service factor, enclosure type, and efficiency requirements for motor specified in Division 23 section “Common Motor Requirements for HVAC Equipment.”
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   b. Motor Speed: 1,800 rpm.
   c. Motor – Single Phase: Induction type, with split phase construction and capacitor start. Open, Drip Proof (ODP) enclosure. Provide permanently lubricated heavy duty ball bearings.
   d. Motor – Three Phase: Induction type, with Open, Drip Proof (ODP) enclosure. Provide permanently lubricated heavy duty ball bearings.
   e. Provide unfused disconnect switch, NEMA 1, selected in accordance with Division 26 section “Enclosed Switches.”
      1) Ship disconnect switch loose for field mounting and wiring.
      2) Factory mount and wire disconnect switch.

f. Frame: Formed square tube steel supports bolted to steel panel with formed inlet venturi and pre-punched holes for mounted anchors. Motor mounted plate bolted to frame tubes.
g. Finish: Galvanized mill finish internal parts, and uncoated external galvanized steel parts exposed to weather.
h. Accessories:
   1) Wall Box: 16 Ga galvanized steel, sized to match dimensions of fan panel, with mounting flange and pre-punched mounting holes. Suitable for attachment of inlet screen, backdraft damper, weather hood, outlet screen, damper guard, and disconnect switch.
   2) Wall Collar: Galvanized steel, to match dimensions of fan mounting plate and wall thickness.
   3) OSHA Motor Side Guard: Complies with OSHA standards by completely enclosing motor and drive components. Constructed of galvanized steel sides and galvanized wire screen.
   4) Weather Hood: G90 galvanized steel hood to shield fan opening from snow and rain. Include bird screen of galvanized wire.
   5) Damper Guard: Provide to protect backdraft damper from birds and debris. Include OSHA-compliant screen. Pre-punch mounting holes.
   6) Backdraft Damper, Automatic, parallel-blade type. Adjust backdraft damper to close when fan is not running.
      a) Fabricate frame from galvanized steel.
   7) Single Point Wiring: Provides a single location for making connections to the disconnect switch.
   8) Filter Box: Contains 2” thick aluminum washable filters.

B. Ceiling Mounted Fans: Ceiling mounted fans shall comply with the following:
   1. The ceiling-mounted circulation fan is the model scheduled with the capacities indicated. The fan shall be furnished with standard mounting hardware and variable speed control to provide cooling and destratification. The fan speed control system is the model scheduled with the capacities indicated. The fan shall be furnished with a wall controller and upper temperature sensor to provide speed control of up to four (4) Powerfoil fans.
   2. Installation of the fan, miscellaneous or structural metal work (if required), field electrical wiring, cable, conduit, fuses and disconnect switches, other than those addressed in the installation scope of work, shall be provided by others. Factory installation services are available through Big Ass Fans. Consult the appropriate installation scope of work for information on the available factory installation options, overview of customer and installer responsibilities, and details on installation site requirements. Installation of the wall controller and upper temperature sensor, field electrical wiring, cable, conduit, fuses, and disconnect switches, other than those address in the installation scope of work, shall be provided by others. Factory installation services are available through Big Ass Fans. Consult the appropriate installation scope of work for information on the

available factory installation options, overview of customer and installer responsibilities, and details on installation site requirements.

3. Shop Drawings: Drawings detailing product dimensions, weight, and attachment methods. Product Data specification sheets on the ceiling-mounted fan and fan speed control system, specifying electrical and installation requirements, features and benefits, and controller information. File provided for architectural design. The manufacturer shall furnish a copy of all operating and maintenance instructions for the fans.
4. The entire fan assembly (without light kit) shall be Intertek/ETL-certified and builtpursuant to the construction guidelines set forth by UL standard 507 and CSA standard 22.2. Sustainability Characteristics: The fan shall be designed to move an effective amount of air for cooling and destratification in a variety of applications (including industrial and agricultural) over an extended life. The fan components shall be designed specifically for high volume, low speed fans to ensure lower operational noise. Sound levels from the fan operating at maximum speed measured in a laboratory setting shall not.
5. The onboard fan controller shall be constructed using a variable frequency drive (VFD) that is pre-wired to the motor and factory-programmed to minimize the starting and braking torques for smooth and efficient operation. The onboard controller shall be prewired to the motor using a short run of flexible conduit with a dedicated ground conductor to minimize electromagnetic interference (EMI) and radio frequency interference (RFI). A 15-ft incoming power cord shall be pre-wired to the controller with one of the following plugs: NEMA L6-20P Twist-Lock Plug, NEMA L6-30P Twist-Lock Plug, NEMA L15-20P Twist Lock Plug, NEMA L16-20P Twist-Lock Plug. As an option, the architect or owner may upgrade to the "harsh environment package," which includes a seal for the weather-resistant onboard VFD enclosure and a motor with IP55 NEMA classification. C. Airfoil System.
6. The fan shall be equipped with eight (8) Powerfoil airfoils of precision extruded aluminum alloy. The airfoils shall be connected by means of two (2) high strength locking bolts per airfoil. The airfoils shall be connected to the hub and interlocked with zinc plated steel retainers. The fan shall be equipped with eight (8) Powerfoil winglets on the ends of the airfoils and eight (8) AirFencesTM positioned on the airfoils at the optimum location for performance. Both the winglet and AirFence shall be molded of polypropylene. The standard color of the winglet and AirFence shall be "Safety Yellow." D. Motor.
7. The fan motor shall be an AC induction type inverter rated at one of the following:
   a. 1725 RPM, 200–240/400–480 VAC, 50/60 Hz, three-phase b. 1725 RPM, 575–600 VAC, 50/60 Hz, three-phase.
8. The motor shall be totally enclosed, fan cooled (TEFC) with an IP44 NEMA classification. A NEMA 56C standard frame shall be provided for ease of service. The motor shall be manufactured with a double baked Class F insulation and be capable of continuous operation in 32oF to 122oF (0oC to 50oC) ambient conditions. The motor shall have a C-face attachment that shall enable technicians

to detach the motor for easy field service. The C-face motor adapter shall be designed to work with the NitroSealTM gearbox. As an option, the architect or owner may upgrade to the "harsh environment package," which includes amotor with an IP55 NEMA classification. As part of the "harsh environment package," the onboard VFD enclosure is sealed for weather-resistant operation. E. Gearbox.

9. The fan gearbox shall be a NitroSealTM Drive designed specifically for the Powerfoil X series. The gearbox shall include a high-efficiency, hermetically sealed, nitrogen-filled, offset helical gear reducer with two-stage gearing, a hollow output shaft, cast iron housing, double lip seals, high quality SKF Explorer Series bearings with crowned cages for optimal lubrication flow, and precision machined gearing to maintain backlash less than 11 arc-minutes over the life of the unit. Lubrication shall be high-grade, low-foaming synthetic oil with extreme pressure additives and a wide temperature range. The gearbox shall be equipped with a hollow shaft threaded to accept a 3⁄4" NPT fitting in which wiring, piping, etc., can be routed to below the fan. A standard junction box can be affixed to this hollow shaft to allow for installing optional features such as lights or cameras. The inclusion of the hollow shaft shall be specified at the time of order. F. Mounting Post.
10. The fan shall be equipped with a mounting post that provides a structural connection between the fan assembly and extension tube. The mounting post shall be formed from A36 steel, contain no critical welds, and be powder coated for corrosion resistance and appearance.
11. The fan mounting system shall be designed for quick and secure installation on a variety of structural supports. The mounting yoke shall be of ASTM A-36 steel, welded construction, at least 3/16" thick, and powder coated for appearance and corrosion resistance. No mounting hardware or parts substitutions, including cast aluminum, are acceptable.
12. The fan hub shall be made of precision cut aluminum for high strength and light weight. The hub shall consist of two (2) aluminum plates, eight (8) aluminum spars and one (1) aluminum spacer fastened with a pin and collar rivet system. 2. The hub shall be secured to the output shaft of the gearbox by means of (10) high strength bolts. The hub shall incorporate five (5) safety retaining clips made of 1/4" (0.6 cm) thick steel that shall restrain the hub/airfoil assembly.
13. The fan shall be equipped with a safety cable that provides an additional means of securing the fan assembly to the building structure. The safety cable shall be Ø3/8" (1 cm) diameter and fabricated out of 7 x 19 galvanized steel cable. The end loops shall be secured with swaged Nicopress® sleeves, pre-loaded and tested to 3,200 lbf (13,345 N). Field construction of safety cables is not permitted.
14. The fan speed control system shall be compliant with NFPA 70-2011—National Electric Code (NEC). 2. Sustainability Characteristics: The system shall be designed to automatically control the speed of Big Ass Fans from the locations of the wall controller and upper temperature sensor to maximize energy savings and user comfort. The system shall be designed specifically for high volume, low speed Big Ass Fans, and receives information from user-determined settings and temperature sensors. Good workmanship shall be evident in all aspects of

installation. The wall control shall be a digital keypad device with an internal temperature sensor. It shall be wall-mounted centrally within the fan zone at head height using two (2) provided 6-32 x 7/8" pan head screws and four (4) provided 6-32 countersink. The wall controller shall be enclosed in a cast zinc cover measuring 3.86" (9.8 cm) x 7.25" (18.4 mm) x 1" (2.5cm) and be made of heavy-duty steel. The wall controller includes a Class II AC Adapter power cord. The wall controller only provides a speed reference for the fan. Start and stop functions are controlled by the auxiliary controller. The mounting location shall meet the requirements of OSHA standard 29 CFR 1910.303(g) for accessibility minimum clearances.

15. The upper temperature sensor shall be mounted in the upper portion of the fan zone either by using a provided I-Beam clamp, or by using four (4) provided mounting screws. The upper temperature sensor shall measure 1.9" (4.8 cm) x 4" (10.2 cm) x 1" (2.5 cm).
16. The fan shall be equipped with an auxiliary controller capable of providing 100% control of all fan functions. The auxiliary controller shall be a digital keypad device mounted within a cast zinc cover. The cover shall be capable of mounting to a standard switch box. The fan shall be equipped with touchpad controls and an LED display for controlling the fan's direction, operation, speed, and programming. Communication between the fan VFD and auxiliary controller is by a standard CAT5 (or higher) Ethernet cable. The auxiliary control comes standard with 150 ft of factory- assembled CAT5 Ethernet cable. The fan shall be equipped with a simple diagnostic program to identify faults in the system. Provisions shall be made for retrieving fan operation and diagnostic data (fault messages) through the auxiliary controller.
17. Includes a 10–30 VDC pilot relay for seamless fire control panel integration. The pilot relay can be wired Normally Open or Normally Closed in the field. Included for installations with extension tubes 4 ft (1.2 m) or longer to limit the potential for lateral movement.
18. The ceiling-mounted circulation fan is the model scheduled with the capacities indicated. The fan shall be furnished with mounting hardware, a remote control, and SenseMETM Technology as manufactured by Haiku® Home.
19. Installation of the fan, wireless network, miscellaneous or structural metal work (if required), field electrical wiring, cable, conduit, fuses and disconnect switches, other than those addressed in the installation scope of work, shall be provided by others. Installation services are available through Haiku Home. Consult the appropriate installation scope of work for information on the available installation options, overview of customer and installer responsibilities, and details on installation site requirements.
20. Shop Drawings: Drawings detailing product dimensions, weight, and attachment methods. Product Data Specification sheets on the ceiling-mounted fan, specifying electrical and installation requirements, features and benefits, and controller information Revit Files: Files provided for architectural design Product Documentation: The manufacturer shall furnish a copy of all installation, operation, and maintenance instructions for the fan.

21. The fan assembly, as a system, shall be Intertek/ETL-certified and built pursuant to relevant safety standards as described above. Sustainability Characteristics: The fan shall possess the ENERGY STAR Most Efficient 2015 designation. The fan shall display good workmanship in all aspects of its construction. Field balancing of the airfoils shall not be necessary.
22. Colors: Airfoil colors may be selected by the architect or owner as described in 2.2.C, "Airfoils." Optional Accessories:
    a. A wall-mounted controller (in addition to the standard remote control) may be selected at the time of order.
    b. An LED light may be selected at the time of order. c. Universal Mount fans: A 0–10 V module may be selected at the time of order. The module shall nable the fan to be integrated with a home or building automation system or a 3rd party 0–10 V dimmer using an industry-standard protocol.

C. Low Profile Mount
    1. The low profile mount shall be suitable for flat ceilings as low as 8 ft (2.4 m) tall. The fan shall be equipped with a mounting plate, rubber bumpers, mounting brackets, a compact low-profile motor hub assembly, and mounting hardware. The fan shall have a diameter of 60" (1.5 m).

D. Standard Mount
    1. The standard mount shall be suitable for flat ceilings with heights ranging from 8.5–12 ft (2.6–3.7 m). The fan shall be equipped with a rubber bushing, mounting bracket, wiring cover, wiring cover trim, standard motor hub assembly, and mounting hardware. c. The fan shall have a diameter of 60" (1.5 m).

E. Universal Mount
    1. The universal mount shall be suitable for flat or sloped ceilings with heights ranging from 8.5–18 ft (2.6–5.5 m). The fan shall be equipped with a mounting bracket, canopy, mounting ball and wedge, extension tubes, wiring cover, motor hub, and mounting hardware. A 7-inch (178-mm), 20-inch (508-mm), and 32-inch (813-mm) extension tube shall be included with the fan. The fan shall have a diameter of 60" (1.5 m).

F. The fan shall be equipped with three airfoils spanning a total diameter of 60 (1.5 m). Airfoils shall be made of glass composite.
    1. Airfoils shall be available in an automotive-grade black or white finish as specified by the architect or owner. Airfoils shall be damp-rated for use in covered outdoor spaces.

G. The fan shall have an electronically commutated motor (ECM) rated for 100–240 VAC, single-phase. The motor shall draw 1.39–31.27 watts depending on the speed at which the fan is operated and if a light is installed. The fan shall be designed for continuous operation in ambient temperatures of 32–104°F (0–40°C), and a humidity range of 20–90% (non-condensing). The fan's motor unit and motor unit trim shall be available in black or white as specified by the architect or owner.

H. The fan shall be equipped with a safety cable that provides an additional means of securing the fan assembly to the building structure. The safety cable shall be 1.5 mm in diameter and fabricated of aircraft steel. 2. Field construction of safety cables is not permitted.

I. The fan shall be equipped with SenseME Technology for smart automation, and shall be able to wirelessly connect to local Ethernet networks or host a network. The fan's Wi-Fi capability shall permit over-the-air firmware updates.

J. SenseME Technology control features shall be managed by users via the Haiku Home app. The Haiku Home app shall be supported by AndroidTM and iOS® mobile digital devices.

K. Haiku Home App Control Modes.
   1. Smart Mode. Alternates between seasonal settings—Smarter Heating and Smarter Cooling—to maintain comfort and maximize energy savings.
      a. Smarter Cooling. The user sets their ideal temperature, and the fan automatically adjusts to find the most comfortable fan speed.
      b. Smarter Heating. Automatically recirculates heat by increasing in speed when the user exits the room. When the user reenters the room, the fan slows.
      c. Smart Thermostat. Automatically signals the fan to switch from Smarter Cooling to Smarter Heating when a connected smart thermostat switches to Cooling or Heating Mode.
   2. Scheduling.
      a. Sets precise schedules for fan control modes.
   3. Whoosh® Mode.
      a. Silently varies fan speed to mimic cooling natural breezes.
   4. Sleep Mode.
      a. Responds to changing conditions to provide customized comfort all night long.
   5. Rooms.
      a. Enables users to group multiple fans in the same space for synchronized operation. Users shall be able to use the Haiku Home app or the optional Haiku Wall Control to automate fan and light functions or adjust settings manually
   6. Manual Speed Control.
      a. Speed settings range from 0 (Off) to 7 (High).
   7. Manual Light Control.
      a. The optional LED light has adjustable brightness and On and Off settings, as well as the ability to be controlled by the motion sensor and scheduling features. For fans with an LED light, see 2.2.H, "LED Light."

L. Haiku Home Account.
   1. Allows for integrated controls between fans and smart thermostats located on the same Wi-Fi network.

2. Sensors
   a. Motion sensor.
      1) The fan and light turn off or on to the last enabled speed or brightness when a person leaves or enters the room.
   b. Temperature and humidity sensor.
      1) The fan monitors room temperature and humidity in order to automatically adjust fan speed to reach the user's optimum thermal comfort level.
   c. Display and sound
      1) Changes to fan settings shall be confirmed with auditory feedback (a beep) and/or visual indication of the active setting.
      2) The fan mode indicators shall be located on the bottom of the fan and shall be visible from the floor. Indicators shall automatically turn off approximately five seconds after a setting is activated.
      3) Users shall have the ability to turn off the indicators and auditory feedback.
   d. Remote Control
      1) The fan shall be equipped with a compact IR remote control that allows intuitive operation of the fan in the following modes:
         a) Speeds 0 (Off) through 7 (High).
         b) Sleep Mode: Pressing the Sleep button on the remote shall activate the user's Haiku Home app Sleep settings or Wake Up settings.
         c) Timer Mode: In Timer Mode, the fan runs at a set speed until the programmed time period ends.
         d) Whoosh Mode: Silently varies fan speed to mimic cooling natural breezes.
      2) The remote shall control both the fan and light. Light brightness shall be increased or decreased by pressing the Up or Down Light button on the remote, and the light shall be turned on or off by pressing the Light On/Off button.
      3) Each operating mode shall be indicated by a pattern on the fan mode indicators, which shall be located on the bottom of the fan and shall be visible from the floor. All indicators shall automatically turn off approximately five seconds after the last control button is pressed.
      4) The remote shall be 1.2" wide x 3.4" tall x 0.2" thick (30 mm wide x 86 mm tall x 5 mm thick), and shall operate on a CR 2025 3 V lithium battery (included). H. LED Light (Optional).
3. The light kit shall include an LED light module, a diffused clear lens and a smoky lens, a lens trim, and mounting screws. The diffused clear lens shall be installed for maximum light emission. The smoky lens shall be installed for softer light emission. I. Haiku Wall Control (Optional)
4. The fan shall be equipped with a wireless Haiku Wall Control in addition to the standard remote control, as specified by the architect or owner. The Haiku Wall Control shall include temperature, humidity, and motion sensors. The user shall

be able to use the Haiku Home app to group the Haiku Wall Control with one or more fans for simultaneous control of fan speed, light brightness, and app features. The Haiku Wall Control buttons shall control both the fan and light (on/off and variable speed/brightness). J. 0–10 V Module (Optional, Universal Mount fans)

5. The fan shall be equipped with a 0–10 V module, as specified by the architect or owner. The module shall be compatible with Universal Mount fans. The module shall be installed in the fan's mounting bracket. The module shall provide independent control of fan speed and light intensity and shall support daisy chaining for one or up to 10 fans. The module shall be compatible with any 0–10 V sinking/sourcing dimmer and with most home or building automation systems.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the work.

B. Examine roughing in for duct systems to verify actual locations of duct connections before fans are installed.

C. Examine foundations and inertia bases for suitable conditions where fans are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FAN INSTALLATION

A. Refer to and follow fan manufacturers guidelines for rigging fans to their location.

B. Install fans level and plumb.

C. Install fans to provide access for periodic maintenance including removing motors, fan wheels, couplings, and accessories.

D. Independently support fans and ductwork so the weight of ductwork is not supported by the fans and weight of fans is not supported by the ductwork.

E. Vibration: Comply with requirements for seismic-restraint devices specified in Division 23 Specification Section "Vibration and Seismic Controls for HVAC Systems."

F. Label units according to requirements specified in Division 23 Specification Section "Identification for HVAC Systems and Equipment."

3.3 PREPARATION

A. Fan location shall have a typical bar joist or existing I-beam structure from which to mount the fan. Additional mounting options may be available.

B. Mounting structure shall be able to support weight and operational torque of fan. Consult structural engineer if necessary.

C. Fan location shall be free from obstacles such as lights, cables, or other building components.

D. Check fan location for proper electrical requirements. Consult installation guide for appropriate circuit requirements.

E. Each fan requires dedicated branch circuit protection.

F. Route power to within six (6) feet of the wall controller location. If additional distance is needed to power the wall controller, consult the alternative wiring method instructions in the Installation Guide. 3.2

G. The fan location must have an appropriate ceiling-mounted outlet box marked, "Acceptable for Fan Support." If there is not an appropriate outlet box already installed at the location, one must be installed on a ceiling joist or beam and be properly wired. Additional mounting options may be available. Consult the installation guide for additional details.

H. The fan location must be free from obstacles such as lights, cables, or other building components.

I. Check the fan location for proper electrical requirements. Consult the installation guide for appropriate circuit requirements.

3.4 INSTALLATION

A. The fan shall be installed by a factory-certified installer according to the manufacturer's Installation Guide, which includes acceptable structural dimensions and proper sizing and placement of angle iron for bar joist applications. Big Ass Fans recommends consulting a structural engineer for installation methods outside the manufacturer's recommendation and a certification, in the form of a stamped print or letter, submitted prior to installation.

B. Minimum Distances
   1. Airfoils shall be at least 10 ft (3 m) above the floor.
   2. Installation area shall be free of obstructions such as lights, cables, sprinklers or other building structures with the airfoils at least 2 ft (0.61 m) clear of all obstructions.

3. The structure the fan is attached to shall be capable of supporting a torque load of up to 300 ft·lb (407 N·m) of torque

C. The fan shall not be located where it will be continuously subjected to wind gusts or in close proximity to the outputs of HVAC systems or radiant heaters. Additional details are in the Big Ass Fans 3.2 Installation Manual.

D. In buildings equipped with sprinklers, including ESFR sprinklers, fan installation shall comply with all of the following:
   1. The maximum fan diameter shall be 24 ft (7.3 m).
   2. The HVLS fan shall be centered approximately between four adjacent sprinklers.
   3. The vertical clearance from the HVLS fan to the sprinkler deflector shall be a minimum of 3 ft (0.9 m).
   4. All HVLS fans shall be interlocked to shut down immediately upon receiving a waterflow signal from the alarm system in accordance with the requirements of NFPA 72 - National Fire Alarm and Signaling Code.

E. The wall control shall be installed by a factory-certified installer according to the Installation Guide.

F. The customer shall supply 2-conductor shielded cable (18-22AWG stranded) to connect the wall control components to the fan's variable frequency drive. The maximum distance between the wall controller and the upper temperature sensor shall be 1000 ft (305 m).

G. Installation areas must be free of obstructions such as lights, cables, sprinklers, or other building structures.

H. The components of the wall control shall not be mounted adjacent to or above radiant heaters, near HVAC ventilation intakes or exhausts, on poorly insulated exterior walls, in roof decking, or near radiant heat sources, and must be mounted so that they are exposed adequately to circulated air. Additional mounting guidelines can be found in the Installation Guide.

I. Install the fan according to the manufacturer's installation guide, which includes acceptable mounting methods.

J. Required Distances
   1. Airfoils must be at least 7 ft (2.1 m) above the floor.
   2. The airfoils must have at least 2 ft (0.6 m) clearance from all obstructions.
   3. The fan must be within a 30 ft (9.1 m) radius of where the mobile digital device will be used for control. (Line-of-sight obstructions may create a smaller maximum range.)
   4. The fan shall not be located where it will be subjected to rain or continuous wind gusts, or in close proximity to the outputs of HVAC systems or radiant heaters. Consult the installation guide for additional details.

K. Install and set up the Haiku Home app according to the manufacturer's instructions.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Specification Section "HVAC Duct Systems and Accessories."

B. Ground equipment according to Division 26 Specification Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Specification Section "Low Voltage Electrical Power Conductors and Cables."

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature control operators.
11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.7 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Division 23 Specification Section "Testing, Adjusting, and Balancing HVAC Systems" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION 233423

SECTION 237313 – MODULAR CENTRAL STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

1.2 SUMMARY

A. This section includes the requirements for modular indoor central station air handling units as follows:
   1. Unit casings.
   2. Fans, drives and motors.
   3. Coil selections.
   4. Air filtration.
   5. Dampers and filter mixing sections.

B. General Description: Factory assembled, consisting of fans, motor and drive assembly, coils, damper, plenums, filters, drip pans, and mixing dampers, etc.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Casing panels shall be self supporting and capable of withstanding 133% of internal static pressures indicated, without panel joints exceeding a deflection of L/200 where "L" is the unsupported span length within completed casings.

1.4 ACTION SUBMITTALS

A. Product Data: For each air handling unit indicated.

   1. Unit dimensions and weight.
   2. Cabinet material, metal thickness, finishes, insulation, and accessories.
   3. Fans:

      a. Certified fan performance curves with system operating conditions indicated.
      b. Certified fan sound power ratings.
      c. Fan construction and accessories.
      d. Motor ratings, electrical characteristics, and motor accessories.

   4. Certified coil performance ratings with system operating conditions indicated.
   5. Dampers, including housings, linkages, pressure drop data and operators.
   6. Filters with performance characteristics, including pressure drop data.

B. Delegated Design Submittal: For vibration isolation indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans 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. Mechanical room layout and relationships between components and adjacent structural and mechanical elements.
2. Support location, type, and weight.
3. Field measurements.

B. Source quality control reports.

C. Field quality control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of the final approved submittal for each product in the operation and maintenance manuals.

B. Maintenance Material Submittals:
1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

a. Filters: One set(s) for each air handling unit.
b. Gaskets: One set(s) for each access door.
c. Fan Belts: One set(s) for each air handling unit fan.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ARI Certification: Air handling units and their components shall be factory tested according to ARI 430, "Central-Station Air Handling Units," and shall be listed and labeled by ARI.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."

F. Comply with NFPA 70.

1.8 QUALITY CONTROL

A. Fan Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes and locations of structural steel support members, if any, with actual equipment provided.

1.10 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Modular indoor central station air handling units shall be designed and selected, for the intended use, in accordance with the scheduled capacities on the drawings and the requirements of this specification.

B. Manufacturers:

C. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Daikin, Vision
2. Air Enterprises, Inc.
3. Munters
4. Annexair

2.2 INDOOR AIR HANDLING UNIT

A. Delivery, Storage, and Handling
1. Deliver, store, protect and handle products to site.
2. Accept products on site on factory-furnished shipping skids. Inspect for damage.
3. Store in clean dry place and protect from construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

B. Unit Construction
1. Fabricate unit with heavy gauge channel posts and panels secured with mechanical fasteners. All panels, access doors, and ship sections shall be sealed with permanently applied bulb-type gasket. Shipped loose gasketing is not allowed.
2. Panels and access doors shall be constructed as a 2-inch nominal thick; thermal broke double wall assembly, injected with foam insulation with an R-value of not less than R-13.
   a. The inner liner shall be constructed of G90 galvanized steel.
   b. The outer panel shall be constructed of G90 galvanized steel.
   c. The floor plate shall be constructed as specified for the inner liner.
   d. Unit will be furnished with solid inner liners.
3. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, maximum 5 inches of positive or 6 inches of negative static pressure. Deflection shall be measured at the panel midpoint.
4. The casing leakage rate shall not exceed 0.50 cfm per square foot of casing surface area at design static pressure up to a maximum of +5” w.c. in positive pressure sections and -6” w.c. in negative pressure sections (.0025 m3/s per square meter of cabinet area at 1.24 kPa static pressure)
5. Module to module field assembly shall be accomplished with an overlapping, full perimeter internal splice joint that is sealed with bulb type gasketing on both mating modules to minimize on-site labor and meet indoor air quality standards.
6. Access doors shall be flush mounted to cabinetry, with minimum of two six inch long stainless steel pianotype hinges, latch and full size handle assembly. Access doors shall swing outward for unit sections under negative pressure. Access doors on positive pressure sections, shall have a secondary latch to relieve pressure and prevent injury upon access.
7. A 6-inch formed G60 galvanized steel base rail shall be provided by the unit manufacturer for structural rigidity and condensate trapping.. The base rail shall

be constructed with 12-gauge nominal for unit sizes 003 - 035 and 10-gauge nominal for unit sizes 040 - 090. The following calculation shall determine the required height of the baserail to allow for adequate drainage. Use the largest pressure to determine base rail height. [(Negative)(Positive) static pressure (in)] (2) + 4" = required baserail height. Should the unit baserail not be factory supplied at this height, the contractor is required to supply a concrete housekeeping pad to make up the difference.

8. Construct drain pans from stainless steel with cross break and double sloping pitch to drain connection. Provide drain pans under cooling coil section. Drain connection centerline shall be a minimum of 3'' above the base rail to aid in proper condensate trapping. Drain connections that protrude from the base rail are not acceptable. There must be a full 2'' thickness of insulation under drain pan.

C. Fan Assemblies
   1. Acceptable fan assembly shall be a double width, double inlet, class II, belt-drive type housed forward curved fan dynamically balanced as an assembly, as shown in schedule. Maximum fan RPM shall be below first critical fan speed. Fan assemblies shall be dynamically balanced by the manufacturer on all three planes and at all bearing supports. Copper lubrication lines shall be provided and extend from the bearings and attached with grease fittings to the fan base assembly near access door. If not supplied at the factory, contractor shall mount copper lube lines in the field. Fan and motor shall be mounted internally on a steel base. Provide access to motor, drive, and bearings through hinged access door.
   2. Fan and motor shall be mounted internally on a steel base. Factory mount motor on slide base that can be slid out the side of the unit if removal is required. Provide access to motor, drive, and bearings through hinged access door. Fan and motor assembly shall be mounted on 2" deflection spring vibration type isolators inside cabinetry.

D. Bearings, Shafts, and Drives
   1. Bearings: Basic load rating computed in accordance with AFBMA - ANSI Standards. The bearings shall be designed for service with an L-50 life of 200,000 hours and shall be a heavy duty pillow block, self-aligning, grease-lubricated ball or spherical roller bearing type.
   2. Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil. Hollow shafts are not acceptable.
   3. V-Belt drives shall be cast iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed. Fixed sheaves, matched belts, and drive rated based on motor horsepower. Minimum of 2 belts shall be provided on all fans with 10 HP motors and above. Standard drive service factor minimum shall be 1.1 S.F. for 1/4 HP – 7.5 HP, 1.3 S.F. for 10 HP and larger, calculated based on fan brake horsepower.

E. Electrical

1. Fan motors shall be manufacturer provided and installed, Open Drip Proof, premium efficiency (meets or exceeds EPAct requirements), 1750 RPM, single speed, 460V / 60HZ / 3P. Complete electrical characteristics for each fan motor shall be as shown in schedule.
2. The air handler(s) shall be ETL and ETL-Canada listed by Intertek Testing Services, Inc. Units shall conform to bi-national standard ANSI/UL Standard 1995/CSA Standard C22.2 No. 236.
3. Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclosed terminal lugs in terminal box sized to NFPA 70.
4. Manufacturer shall provide ASHRAE 90.1 Energy Efficiency equation details for individual equipment to assist Building Engineer for calculating system compliance.
5. Installing contractor shall provide GFI receptacle within 25 feet of unit to satisfy National Electrical Code requirements.
6. All electrical connection components shall be field provided and mounted as shown on project schedule.

F. Cooling and Heating Coils
1. Certification – Acceptable refrigerant coils are to be verified in accordance with AHRI Standard 410 and bear the AHRI label. Coils exceeding the scope of the manufacturer's certification and/or the range of AHRI's Standard rating conditions will be considered provided the manufacturer is a current member of the AHRI Air-Cooling and Air-Heating Coils certification programs and that the coils have been rated in accordance with AHRI Standard 410. Manufacturer must be ISO 9002 certified.
2. Water Refrigerant coil shall be provided. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.
    a. Coils designed for use with Refrigerant R410a. Fins shall have a minimum thickness of 0.0075 of aluminum plate construction with full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary-to-secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tube shall not be visible between fins.

b. Refrigerant coils shall be provided with round seamless 5/8" O.D. copper tubes on 1-1/2" centers, staggered in the direction of airflow. All joints shall be brazed.
c. Sweat type copper suction connections located at the bottom of the suction headers for gravity oil drainage. Coils shall be uniformly circuited in a counterflow manner for single circuit capacity reduction. Pressure type liquid distributors used. Coils shall be tested with 315 pounds air pressure under warm water, and suitable for 250 psig working pressure.

3. Electrical Heating:
   a. ETL-approved electrical heaters for horizontal-mounted draw through units in both left and right hand configurations. All units are open wire style construction, with automatic and manual backup limit controls, air switch, stainless steel terminals, power on pilot light, magnetic contractors and integral control boxes. Safety interlock switches, step controllers and Vernier silicon controlled rectifiers. (SCRs).
   b. The heater requires its own electrical service. Heaters are available in 208V, 240V, 480V and 600V (all 3 phase) and use internal 24-volt control circuit.
   c. An integral control box with door handle power disconnect is included with the electrical heater. Insulated panels are factory installed behind the control box.

2.3 FILTERS

A. Furnish flat panel filter section with 2-inch pleated MERV 8 filter. Provide side loading and removal of filters.

B. Filter media shall be UL 900 listed, Class I or Class II.

C. Filter Magnehelic gauge(s) shall be furnished and mounted by others.

2.4 ADDITIONAL SECTIONS

A. Mixing box section shall be provided with end outside air opening and top return air opening with or without parallel low leak airfoil damper blades. Dampers shall be hollow core galvanized steel airfoil blades, fully gasketed and have continuous vinyl seals between damper blades in a galvanized steel frame. Dampers shall have stainless steel jamb seals along end of dampers. Connecting linkage and ABS plastic end caps shall be provided when return and outside air dampers are each sized for full airflow. Return and outside air dampers of different sizes must be driven separately. Damper Leakage: Leakage rate shall be less than two tenths of one percent leakage at 2 inches static pressure differential. Leakage rate tested in accordance with AMCA Standard 500.

2.5 Outdoor Condensing Unit

A. Unit Description: Scroll Option Provide and install, as shown on the plans, a factory-assembled, air-cooled scroll compressor condensing units in the size and quantity

specified. Each unit shall consist of hermetic tandem or triple scroll compressor sets, air cooled condenser section. Design Requirements: Provide a complete condensing unit as specified herein and as shown on the drawings. Refer to schedule of performance on the drawings. Performance shall be in accordance with ARI Standard 365-94.

B. Condensing Section
   1. Air Cooled Condenser
      a. Each condenser coil shall be factory leak tested with high-pressure are under water. Each refrigerant circuit shall provide 15 degrees of liquid subcooling.
      b. Condenser coils shall be fabricated from cast aluminum micro-channel coils. Each condenser coil shall be factory leak tested with high-pressure air under water. Coils are to be recessed so that the cabinet provides built in hail protection.
      c. Condenser fans shall be 1140 rpm direct drive., propeller type designed for low tip speed, vertical air discharge and include service guards. Fan blades shall be constructed of steel and riveted to a steel center hub. Condenser fan motors shall be heavy-duty, inherently protected, three phase, non-reversing type with permanently lubricated ball bearing and integral rain shield.
      d. Units shall have at least one condenser fan controlled to maintain positive head pressure. An ambient thermostat shall prevent the refrigeration system from operating below 45°F ambient.
   2. Scroll Compressors
      a. Unit shall have multiple, heavy duty Copeland scroll compressors.
      b. Each compressor shall be complete with gauge ports, oil sight glass, crank case heater, anti-slug protection, and a time delay to prevent short cycling and simultaneous starting of compressors following power failure.
      c. Compressors shall be isolated with resilient rubber isolators to decrease noise transmission.
      d. Refrigeration capacity control shall be accomplished by staging of the units multiple compressors. Liquid tight conduit shall be provided on exposed compressor wire.
      e. Each compressor shall have motor temperature sensing and current sensing overload protection.
   3. Refrigerant Circuit: Manual chagrining/ evacuation valve and capped connections shall be provided for field connection of refrigerant piping.
      a. Refrigerant specialties shall be field supplied and installed.
      b. The unit shall have two independent refrigeration circuits.

C. Controls
   1. Unit shall be equipped with a low pressure and high pressure safetly for each refrigerant circuit.
   2. Unit manufacturer shall provide necessary relays for cooling stages as stated on equipment schedule.
   3. Field powered 115V outlet.

D. Accessories
   1. Hot gas bypass kit for one circuit to allow unit operation to 10 percent of full load.
   2. VFD condenser fan speed control shall be added to the last fan off on each refrigeration circuit to provide cooling operation to ambient temperatures down to 0°F.
   3. Unit shall be equipped with a 24 V terminal strip for field supplied and installed controls.
   4. Non-fused disconnect switch with through-the-door handle.
   5. ElectroFin baked epoxy coating providing 3000+ hour salt spray resistance (ASTM B117-90) and is applied to both the coil and the coil frames.
   6. Spring vibration isolators for field installation.
   7. Vandal guards.
   8. Factory powered 115 V convenience outlet.
   9. The manufacturer will provide extended 48 month, parts only, warranty on the compressor.
   10. The condensing unit shall be designed, manufactured, and independently tested, rated, and certified to meet the seismic standards of the 2009 International Building Code and ASCE 7-06.
      a. Certificates of Compliance shall be provided with the quotation and include the manufacturer's identification, designation of certified characteristics, and the Independent Certifying Agency's name and report identification.
      b. Clear installation instructions shall be provided including all accessory components.
   11. Suction and discharge isolation valves for each refrigeration circuit.

2.6 Indoor Air Handling Unit (Chilled Water Coils)

A. Equipment Design and Selection: Modular indoor central station air handling units shall be designed and selected, for the intended use, in accordance with the scheduled capacities on the drawings and the requirements of this specification.

B. Manufacturers:

C. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

   1. Carrier Corporation; a member of the United Technologies Corporation Family.
   2. McQuay International
   3. Trane; American Standard Inc.
   4. YORK International Corporation.
   5. PETRA (Basis of Design)

2.7 UNIT CASINGS

A. General Fabrication Requirements for Casings: Comply with the following:

1. Forming: Form walls, roofs, and floors with at least two (2) breaks at each joint.
2. Medium and high pressure units shall be constructed with additional bracing and supports. Units rated at 5.5 inches wg and higher shall be connected to accessories sections with double thickness neoprene coated flexible connection.
3. Casing Joints: Sheet metal screws or pop rivets.
4. Sealing: Seal all joints with water resistant sealant.
5. Factory Finish for Galvanized Steel Casings: Apply manufacturer's standard primer immediately after cleaning and pretreating.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Casing Insulation and Adhesive: Comply with the following:

1. Materials: ASTM C 1071, Type II.
2. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from, and including, the cooling-coil section.

    a. Liner Adhesive: Comply with ASTM C 916, Type I.
    b. Mechanical Fasteners: Mechanical fasteners shall be galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
    c. Liner Materials: Liner materials applied in this location shall have air-stream surface coated with a temperature resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.

3. Location and Application: Encased between outside and inside casing.

C. Inspection and Access Panels and Access Doors: Comply with the following:

1. Panel and Door Fabrication: Panels and doors shall be formed and reinforced, single wall or double wall and insulated panels of same materials and thicknesses as casing.
2. Inspection and Access Panels:

    a. Fasteners: Provide two (2) or more camlock type for panel lift out operation. Arrangement shall allow panels to be opened against air pressure differential.
    b. Gasket: Neoprene gaskets shall be applied around entire perimeters of panel frames.
    c. Size: Large enough to allow inspection and maintenance of air handling unit's internal components.

3. Access Doors: Comply with the following:

    a. Hinges: Provide a minimum of two (2) ball-bearing hinges or stainless steel piano hinge and two (2) wedge lever type latches, operable from inside and outside. Arrange doors to be opened against air pressure differential.
    b. Gasket: Neoprene gaskets shall be applied around entire perimeters of panel frames.

4. Locations and Applications: Comply with the following:

    a. Fan Section: Doors.
    b. Access Section: Doors.
    c. Coil Section: Inspection and access panel.
    d. Damper Section: Inspection and access panels.
    e. Filter Section: Doors large enough to allow periodic removal and installation of filters.
    f. Mixing Section: Doors.

D. Condensate Drain Pans: Comply with the following:

1. Slope: Drain pans shall be fabricated with 1% slope in at least two (2) planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
2. Single-wall, stainless steel sheet.
3. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one (1) end of pan.

    a. Minimum Connection Size: NPS 1.

4. Pan-Top Surface Coating: Surface coating shall be asphaltic waterproofing compound.
5. Intermediate Drain Pan - Stacked Coils: Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

E. Air Handling Unit Mounting Frame: Provide formed galvanized steel channel or structural channel supports, designed for low deflection, and welded with integral lifting lugs.

1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to air-handling unit sections, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Specification Section "Vibration and Seismic Controls for HVAC Systems" when air handling unit frame is anchored to building structure.

2.8 FAN, DRIVE, AND MOTOR SECTION

A. General: Sound power level ratings shall comply with AMCA Standard 301 "Method for Calculating Fan Sound Ratings from Laboratory Test Data" and shall be the result of tests made in accordance with AMCA standard 300 "Test Code for Sound Rating" Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.

B. Fan Performance Rating: Unit's fans performance ratings for flow rate, pressure, power, air density, speed or rotation, and efficiency shall be factory tested and ratings established in accordance with AMCA Standard 210/ASHRAE Standard 51 – Laboratory Methods of Testing Fans for Rating.

C. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower.

1. Shafts: Shafts shall be designed for continuous operation at maximum rated fan speed and motor horsepower, and with field adjustable alignment.

a. Turned, ground, and polished hot rolled steel with keyway. Ship with a protective coating of lubricating oil.
b. Designed to operate at no more than 70% of first critical speed at top of fan's speed range.

D. Centrifugal Fan Housings: Housings shall be formed and reinforced steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

1. Bracing: Provide steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Horizontal Flanged, Split Housing: Bolted construction.
3. Housing for Supply Fan: Attach housing to fan section casing with metal-edged flexible duct connector.
4. Flexible Connector: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two (2) strips of 2-3/4 inch wide, 0.028 inch thick, galvanized steel sheet or 0.032 inch thick aluminum sheets; select metal compatible with casing.
   a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

      1) Fabric Minimum Weight: 26 oz./sq. yd..
      2) Fabric Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
      3) Fabric Service Temperature: - 40°F to + 200°F.

E. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.

F. Fan Wheels: Fan wheels shall be as follows:

1. Forward Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; cast steel hub swaged to backplate and fastened to shaft with set screws.

G. Fan Shaft Bearings: Comply with the following:

1. Grease Lubricated Bearings: Self aligning, pillow block type, ball or roller bearings with adapter mount and two (2) piece, cast iron housing with grease lines extended to outside unit.

H. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning, and with 1.4 service factor based on fan motor.

1. Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
2. Motor Pulleys: Adjustable pitch for use with 15 hp motors and smaller; fixed pitch for use with motors larger than 15 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
3. Belts: Oil resistant, nonsparking, and nonstatic; in matched sets for multiple belt drives.
4. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.1046 inch thick, three quarter (3/4) inch diamond-mesh wire screen, welded to steel angle frame; prime coated.

I. Discharge Dampers: Heavy duty steel assembly with channel frame and sealed ball bearings, and opposed blades constructed of two (2) plates formed around and welded to shaft, with blades linked out of air stream to single control lever.

J. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Specification Section "Motor Requirements for HVAC Equipment."

1. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
4. Mount unit mounted disconnect switches on interior of unit.

K. Variable Frequency Drives See Division 26 Specification Section “Variable Frequency Drives” for requirements.

2.9 COIL SECTION

A. General Requirements for Coil Section: Comply with the following:

1. Comply with ARI 410.
2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in place access for service and maintenance of coil(s).
3. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
4. Coils shall not act as structural component of unit.
5. Seismic Fabrication Requirements: Fabricate coil section, internal mounting frame and attachment to coils, and other coil section components with reinforcement strong enough to withstand seismic forces defined in Division 23 Specification Section "Vibration and Seismic Controls for HVAC Systems" when coil mounting frame and air handling unit mounting frame are anchored to building structure.

B. Coils, General: Drainable, rigidly supported across the full face of the coil, and pitched to allow drainage.

1. Fins: Aluminum or copper, constructed form flat plate with belled collars for tubes. Fins shall be bonded to tubes by mechanically expanding copper tubes.
2. Tubes: Seamless copper.
3. Coil Casing: Galvanized steel.
4. Headers for Water Coils: Steel or cast iron, with connections for drain valve and air vent and threaded piping connections.

2.10 AIR FILTRATION SECTION

A. General Requirements for Air Filtration Section: Comply with the following:

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
4. Spare Filters: Provide two (2) sets of spare filters for each type of filter media. One (1) set of spare of filters shall be installed in the air handling unit for the testing and balancing procedure. The second set of spare filter media shall be turned over to the owner.
5. Air Handling Unit Operation during Construction: When the air handling units need to be operated during construction the contractor shall provide the filters for the air handling unit. These filters shall be separate from the specified filter media. Install specified filter media prior to final test and balance of air handling systems.

B. Filter Types: Comply with the following:

1. Disposable Pre Filter Media:

Filter Media: Filter media shall have an average efficiency of 25% to 30% and an average arrestance of 90% to 92% in accordance with ASHRAE Test Standard 52.2.

1) Two (2) inch Filter: Filter faced area shall contain not less than 15 pleats per linear foot. Initial resistance at 500 fpm shall not exceed .28 inch wg.

b. Media Support Grid: Grid shall be welded wire on one (1) inch centers with an open area of not less than 96%. Grid shall be bonded to the media to eliminate oscillation and pull away. The grid shall be formed to affect a radial pleat, allowing total use of media.

1) Enclosing Frame: The frame shall be a rigid, high wet-strength beverage board, with diagonal support members bonded to the air entering and exiting side of each pleat. The enclosing frame shall be chemically bonded to the filter pack.

c. Final Filter Media – Pleated Type:

1) Air filters shall be high performance, deep pleated, totally rigid and totally disposable type. Each filter shall consit of high density media, media support grid, contour stabilizers, diagonal support bracing and enclosing frame.
a) 90% to 95% Efficient – Filter media shall be of high density micro fine glass fibers, laminated to a reinforcing backing to form a lofted filter blanket. The filter media shall have an average efficiency of 90-95% on ASHRAE Test Standard 52.2). It shall have an average arrestance3 of not less than 99% on that standard. Filters shall be listed by Underwriters' Laboratories as Class (2) (1).

2) Media Support Grid – The media support shall be a welded wire gird 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 pull away. The media support gird shall be formed in such a manner that it affects tapered radial pleat design. The grid shall be designed to support the media both vertically and horizontally.

3) Contour Stabilizers – Contour stabilizers shall be galvanized steel and shall be permanently installed on both the air entering and air exiting sides of the filter media pack to insure that the tapered radial pleat configuration is maintained throughout the life of the filter. There shall be four contour stabilizers on the air entering side and six on the air exiting side. The filter shall be capable of withstanding 10 inch wg. pressure drop without noticeable distortion of the media pack.

4) Enclosing Frame – The enclosing frame shall be constructed of galvanized steel. It shall be assembled in such a manner that a rigid and durable enclosure for the filter pack is affected. The media pack shall be mechanically and chemically bonded to the inside of the periphery of the enclosing frame, thus eliminating the possibility of air by-pass. The enclosing frame shall be equipped with galvanized steel protective diagonal support braces on both the air entering and air exiting sides of the filers. The diagonal support braces shall be mechanically fastened to each contour stabilizer.

2.11 DAMPERS AND COMBINATION FILTER MIXING SECTION

A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2% of air quantity at two thousand (2,000) fpm face velocity through damper and four (4) inch wg pressure differential.

B. Damper Operators: Comply with requirements in Division 23 Specification Sections for "Building Automation Systems."

C. Face and Bypass Dampers: Opposed blade, galvanized steel dampers with steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized steel frame and with operating rods connected with a common linkage. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod.

D. Outdoor and Return Air Mixing Dampers: Parallel blade, galvanized steel dampers mechanically fastened to steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

E. Mixing Section: Multiple blade, air mixer assembly located immediately downstream of mixing section.

F. Combination Filter and Mixing Section:

1. Cabinet support members shall hold two (2) inch thick, pleated, flat, permanent or throwaway filters.

2. Multiple blade, air mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the work.

B. Examine casing insulation materials and filter media before air handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing in for hydronic, piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

E. Install in accordance with manufacturer's Installation & Maintenance instructions.

3.2 INSTALLATION

A. Equipment Mounting:

1. Install air handling units on cast in place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Architectural Specification Section's "Cast in Place Concrete." and/or "Miscellaneous Cast in Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Division 23 Specification Section "Vibration and Seismic Controls for HVAC Systems."

B. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

C. Install filter gauge, static pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static pressure taps upstream and downstream of filters.

D. Provide one extra set of fan belts, filters for each unit.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air handling unit to allow service and maintenance.

C. Connect piping to air handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Water Piping: Comply with applicable requirements in Division 23 Specification Section “HVAC Piping Systems and Specialties.”

F. Connect duct to air handling units with flexible connections. Comply with requirements in Division 23 Specification Section "HVAC Duct Systems and Accessories."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.
2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

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

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connection's to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations.
5. Verify that bearings, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that outdoor and return air mixing dampers open and close, and maintain minimum outdoor air setting.
7. Comb coil fins for parallel orientation.
8. Install new, clean filters.
9. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Division 23 Specification Section "Testing, Adjusting, and Balancing HVAC Systems" for air handling system testing, adjusting, and balancing.

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing air handling unit and air distribution systems and after completing startup service, clean air handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train the owner's maintenance personnel to adjust, operate, and maintain air handling units.

END OF SECTION 237313

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SECTION 260000 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section and all other Electrical Specification Sections.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements, as well as the following basic electrical materials and methods:

1. Submittals.
2. Record documents.
3. Operation and Maintenance manuals.
4. Rough-ins.
5. Electrical installations.
6. Cutting and patching.
7. Access to electrical installations.

B. Summary of Work:

1. Provide a complete integrated electrical system in accordance with the intent of these specifications and the accompanying drawings.

1.3 REFERENCED ORGANIZATIONS AND CODES

A. The following list of abbreviations, are utilized within the specifications and are provided as a reference.

B. All work in Divisions 26, 27, and 28 shall comply with the latest version of following codes and regulations as adopted by the State of Maryland and the State Fire Marshal, unless otherwise specified.

1. NFPA (National Fire Protection Association).
2. NESC (National Electrical Safety Code).
3. ADA (American with Disabilities Act).
4. ANSI (American National Standards Inst.).
5. OSHA (Occupational Safety & Health Act).
6. COMAR (Code of Maryland Regulations).
7. UL (Underwriters Laboratories).
8. IBC (International Building Code).
9. State of Maryland Fire Prevention Code.
10. ANSI/EIA/TIA.

11. NETA (National Electrical Testing Association).
12. NEMA (National Electrical Manufacturer's Association).
13. NECA (National Electrical Contractors Association).

1.4 OUTAGES

A. For all work requiring an outage, the contractor shall submit an outage request to the UMB Project Manager, using the UMB Standard Request for Outage Form which is available through the UMB Design and Construction Web Site at http://www.umaryland.edu/designandconstruction/, under the Documents Link. The existing mechanical/electrical systems shall remain operational unless turned off by University personnel during the construction of the project. For each electrical outage request include a photograph of the panel index schedule for each panel affected by the outage.

B. Unless otherwise specified, outages of any services required for the performance of this contract and affecting areas other than the immediate work area shall be scheduled at least ten days (10) days in advance with the Office of Facilities Management. All such outages shall be performed on other than normal duty hours.

C. All electrical outages which will interfere with the normal use of the building in any manner shall be done at such times as shall be mutually agreed upon by the contractor and the Office of Facilities Management.

D. The contractor shall include in his price the cost of all premium time required for outages and other work which interferes with the normal use of the building, which will be performed, in most cases, during other than normal work time and at the convenience of the University.

E. The operation of electrical equipment; required to achieve an outage must be accomplished by University personnel only. Prospective subcontractors under this section are cautioned that the unauthorized operation of electrical equipment or other control devices by their personnel can result in extremely serious consequences for which the contractor will be held accountable.

1.5 INSTALLER'S QUALIFICATIONS

A. Electrical Installer shall submit the following evidence:

1. Five (5) comparable completed projects.
2. Reference letters from minimum of three (3) registered professional engineers, general contractors, building owners, explaining proficiency, quality of work, or other attribute on projects of similar size or substance.
3. Copy of Maryland Master Electrician's License.
4. Local or State license where required.
5. BICSI and NICET certification, where required by these specifications.

B. The electrical installer shall utilize a full time project foreman in charge of all electrical work.

1. Fully qualified and experienced in such work.
2. Available, on site, at all times during construction.
3. All communication shall be through this person.

C. Installer of specialized systems such as Fire Alarms, telecommunication systems, etc. shall meet the requirements of the associated spec section(s).

1.6 CUTTING, WELDING, BURNING

A. Before the contractor and/or any sub-contractor commence's any cutting, welding, and/or burning, the contractor shall obtain a hot work permit from Environmental Health and Safety at extension 1-410-706-3490.

B. The hot work permit copy shall remain on the job site at the hot work location until such work is completed at which time the permit shall be returned to Environmental Health and Safety.

1.7 WORK PERFORMANCE

A. All electrical work must comply with the requirements of NFPA 70 (NEC), NFPA 70B, NFPA 70E, OSHA Part 1910 subpart J, OSHA Part 1910 subpart S and OSHA Part 1910 subpart K in addition to other references required by the contract.

B. Before initiating any work, a job specific work plan must be developed by the contractor. The work plan must include procedures to be used on and near the live electrical equipment, barriers to be installed, and safety equipment to be used and exit pathways.

C. Job site and worker safety are the responsibility of the contractor. Compliance with the requirements of NFPA 70E is subject to ongoing inspection by University personnel and failure to comply will result in an immediate Stop Work order being issued and enforced at the contractor's expense.

D. Energized electrical conductors and circuit parts to which an employee might be exposed shall be put into an electrically safe work condition before an employee performs work any time the employee is within the limited approach boundary or, where an increased risk of injury from an exposure to an arc flash hazard exists.

E. Outages should be scheduled a minimum of ten (10) days in advance.

F. Mandatory Requirements: The following requirements are mandatory:

1. Protective Equipment: Electricians must use full protective equipment (i.e., certified and tested insulating material to cover exposed energized electrical

components, certified and tested insulated tools, etc.) while working on energized systems in accordance with NFPA 70E.

2. UMB Energized Work Permit: A UMB Energized Work Permit is required for any work on energized circuits or equipment. Permit must be approved by UMB Department of Operations and Maintenance prior to performing energized work. Submit the work permit with the outage request.

1.8 SUBMITTALS

A. General: Follow the procedures specified in Division 01 Section "Submittals."

B. Product data as specified in the electrical specifications.

C. Shop drawings detailing fabrication and installation requirements for electrical equipment.

D. In addition to the following list, submit other shop drawings as may be requested by UMB.

1. Divisions 26, 27, & 28:
   a. Compression Wire Connectors
   b. Fire Resistant Sealant
   c. Ground Wire
   d. Surface Raceway
   e. Wireways
   f. Raceway, Boxes and Cabinets
   g. Wires and Cables
   h. Fire Alarm System: Refer to Division 28 Section “Digital, Addressable Fire Alarm System” for submittal requirements

E. In instances of complex field wired systems, including but not limited to: fire alarm system, the contractor shall submit:

1. Cut sheets of every component such as control panels, fire alarm devices, wire, etc.
2. The contractor shall submit detailed riser diagrams detailing point-by-point connections. Diagrams shall indicate cable on raceway between points.
3. Corresponding floor plans showing only this particular system with conduit and wire runs between points.
4. Both riser and floor plan shall indicate address of devices where applicable.
5. Calculations for battery capacity and voltage drop.
6. Preliminary programming information.

F. Submittal File Format: File formats for each submittal shall be electronically as follows:

1. Product Data: “pdf” file format.

2. Shop Drawings: “pdf” file format.
3. Coordinated Drawings: “pdf” or “dwg” file formats.

1.9 QUALITY ASSURANCE

A. Comply with NFPA 70 for components and installation.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms “Listed and Labeled”: As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A “Nationally Recognized Testing Laboratory” (NRTL) as defined in OSHA Regulation 1910.7.

C. Install all components and equipment per manufacturer’s written instructions.

D. Provide installation in accordance with recognized trade organizations and standards:

1. NEMA.
2. NECA “Standards of Installation”

1.10 COORDINATION DRAWINGS

A. General: When required participate in the preparation of the coordinated drawing effort for the project. See Specification Division 01 for general requirements.

B. Coordination Drawings: In addition to the requirements of the Specification Division 01 prepare the electric part for the coordination drawing effort. Work with the other trades to ensure the material and equipment installed as part on the electrical system will not be in conflict with the installation of material and equipment by the other trade contractors. Unless otherwise indicated the coordination drawings, including plans, sections, and elevations shall be prepared at a scale of not less than 1/4 inch = 1 foot- 0 inches. At a minimum, prepare coordination drawings for all mechanical rooms, electrical rooms and substation rooms.

C. File Format: Coordination drawings shall be in a layered structure form as CAD Files or PDF Files for each floor with searchable text as follows:

1. File Structure: The “pdf” or “dwg” files shall have separate layered structure for:

a. Building Elements: Indicate each building element on separate layers, such as:

1) Walls.
2) Reflected ceiling plan.
3) Room numbers.

b. Systems and Sub Systems: Indicate each system or sub system as warranted by congestion or complexity on separate layers such as:

1) Examples of Systems:
   a) Lighting System.
   b) Power Distribution System.
   c) Control/ SCADA System

2) Examples of Sub Systems:
   a) Normal Power.
   b) Emergency Power.

2. The layered electronic files shall allow building elements, building systems and sub systems to be viewed in isolation or in combinations that are user selectable when the drawing files are being displayed.

D. Coordination Effort: This coordination effort shall include detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of electrical equipment, and materials. Include the following:
   a. Planned electrical systems layout, including conduit elbow radii and accessories.
   b. Clearances for servicing and maintaining electrical equipment.
   c. Exterior wall and foundation penetrations.
   d. Fire rated wall and floor penetrations.
   e. Sizes and location of required concrete pads and bases.
   f. Size and location of all electrical panels.
   g. Access doors.
2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations. Show all access doors for concealed junction boxes devices.
4. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, cable trays, sprinklers, access doors and other ceiling mounted items.

1.11 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 01 Section "Contract Closeout." In addition to the requirements specified in Division 01, indicate the

following installed conditions:

1. Conduit and wire runs between the points
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, RFI responses and actual equipment and materials installed.

1.12 OPERARTION AND MAINTENANCE MANUALS

A. Electrical O & M Manual File: Provide one (1) electronic file "pdf format" for the projects Electrical Operation and Maintenance Manual for the Material and Equipment installed in the project included in Divisions 26 on a CD-R. The electronic Electrical O & M manual shall include one copy of each approved submittal, any manufacturer's maintenance manuals, all warranty certificates, arranged in file folders for each submittal. Also include the address, phone number and contact person for each supplier. Files shall be stacked and include both a book mark and tree structure for accessing each submittal file as indicated in Division 01 Section "Closeout Procedures".

A. Provide service and operating manuals for the following:

1. Division 28 Section "Digital, Addressable Fire Alarm System".

1.13 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.14 SEQUENCING AND SCHEDULING

A. Coordinate electrical equipment installation with other building components.

B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for electrical installations.

C. Coordinate the installation of required supporting devices and set sleeves in poured in place concrete and other structural components as they are constructed.

D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.

E. Coordinate connection of electrical services.

F. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised

service companies, and controlling agencies.

G. Coordinate requirements for access panels and doors where electrical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in the Architectural Specifications.

H. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.

1.15 VARIANCES

A. Where variances occur between the drawings and specifications or within either document itself, the item or arrangement of better quality, greater quantity or higher cost shall be included in the contract price. The Engineer shall decide on the item and manner in which the work shall be provided.

1.16 GUARANTEE/WARRANTY:

A. All materials, equipment, etc. provided by the general contractor and/or his subcontractors shall be guaranteed and warranted to be free from defects in workmanship and materials for a period of two (2) years after date of certificate of completion and acceptance of work by UMB. Any defects in workmanship, materials, or performance which appear within the guarantee period shall be corrected by the contractor without cost to the owner, within a reasonable time, to be specified by UMB. In default thereof, owner may have such work done and charge the cost of same to the contractor. In addition to the above statement the Guarantee/Warranty Period shall include all labor cost related to all warranty work. For compressorized equipment include an additional three (3) year Guarantee/Warranty Period.

PART 2 - PRODUCTS

2.1 LISTED MANUFACTURERS:

A. Listed Manufacturers: The listed manufacturers indicated in Part 2 of each specification section as the basis of design represents the minimum level of quality for materials and equipment that is acceptable to UMB. Unless otherwise indicated in each specification section, contractors may submit material and equipment by non listed manufacturers provided said submittals meet the requirements of these specifications. All submitted materials and equipment are subject to approval by the A/E and UMB.

B. Approved Equal Equipment Layouts: The equipment layouts and the related mechanical and electrical service connections, access space and supports indicated on the construction documents represent equipment provided by the specified basis of design manufacturer and model number. When the successful bidder chooses to provide “or approved equal” equipment by one (1) of the other listed manufacturers in the specifications, the bidder shall be responsible for providing all adjustments and

modifications to the services necessary to make connections to the equipment, the bidder shall be responsible for installing the equipment such that all required clear access space is maintained, and the bidder shall be responsible for providing all adjustments and modifications to the equipment mounting and supports. All adjustments and modifications shall be provided by the bidder and appropriate subcontractors at no additional cost to the project.

PART 3 – EXECUTION

3.1 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. For equipment rough-in requirements see specifications for electrical equipment.

3.2 ELECTRICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with other building components.
2. Verify all dimensions by field measurements.
3. Install systems, materials, and equipment to conform with approved submittal data, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to UMB.
4. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
5. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
6. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.3 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 1 Section "Cutting and Patching." In addition to the requirements specified in Division 1, the following requirements apply:

1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

B. Perform cutting, fitting, and patching of electrical equipment and materials required to:

1. Uncover Work to provide for installation of ill timed Work.
2. Remove and replace defective Work.
3. Remove and replace Work not conforming to requirements of the Contract Documents.
4. Disconnect installed work as specified for testing.
5. Install equipment and materials in existing structures.
6. Upon written instructions from UMB, uncover and restore Work to provide for UMB observation of concealed Work.

C. Cut, remove and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical systems and equipment as indicated on the drawings and specifications and other electrical items made obsolete by the new Work.

D. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

1. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.
   a. Refer to Division 01 Section "Definitions and Standards" for definition of "experienced Installer."

2. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.
   a. Refer to Division 01 Section "Definitions and Standards" for definition of "experienced Installer."

3.4 PROTECTION OF WORK

A. Protect work, material and equipment from weather and construction operations before and after installation.

B. Properly store and handle all materials and equipment.

C. Cover temporary openings for electrical equipment to prevent the entrance of water, dirt, debris, and other foreign matter.

3.5 PROVISIONS FOR ACCESS

A. Furnish and install adequate access to all electrical components. The following list shall be used as a guide only:

1. Equipment such as transformers, generators, etc.
2. Distribution panels.
3. Switch Gear.
4. Disconnects.
5. Variable frequency drives.

B. Access shall be as required by code and/or as determined by the Architect and Engineer.

C. Refer to contract drawings where access panels have been specifically located.

D. Where access is by means of lift out ceiling tiles or panels mark access each panel using small color coded or numbered tabs. Provide an index chart for identification. Place markers in corner of tile.

3.6 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of equipment and systems to Owner's personnel a minimum two (2) weeks prior to date of final inspection.

1. For equipment requiring seasonal operation, perform instructions for other seasons at the same time.
2. Training period shall be performed within one (1), two (2) week period.

B. Use operation and maintenance manuals and video as basis of instruction. Review contents of manual and video with personnel in detail to explain all aspects of operation and maintenance.

C. Demonstrate the following:

1. Start up.
2. Operation.
3. Control.
4. Adjustment.
5. Trouble shooting.
6. Servicing.
7. Maintenance.
8. Shutdown.

D. Provide at least forty (40) hours straight time instruction to the operating personnel.

1. This instruction period shall consist of not less than five (5) eight (8) hour days.
2. Time of instruction shall be designated by the Owner.
3. This instruction shall be in addition to instructional requirements of specific

equipment specified elsewhere in the mechanical specifications.

3.7 EQUIPMENT PROVIDED UNDER ANOTHER DIVISION AND BY OTHERS

A. The Installer of products under Divisions 26, 27, & 28 shall make all system connections required to equipment furnished and installed under another division and by others.

B. It shall be the responsibility of the Installer to obtain all necessary data from the equipment supplied under other Divisions.

3.8 RECORD DRAWINGS (As Built)

A. Upon completion of the electrical installations, the Installer shall deliver to the Architect one (1) complete set of marked-up blueprints of the electrical contract drawings.

1. The mark-ups shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design.
2. Refer to General Requirements of Division 01 for additional requirements pertaining to Submittals and Record Drawings.

3.9 CLOSEOUT PROCEDURES

A. Operating and Maintenance Instructions: Submit Complete Package At Least Two (2) Months Prior To Substantial Completion. Arrange for each installer of equipment that requires regular maintenance to meet with the Owner's personnel to provide instruction in proper operation and maintenance. If installers are not experienced in procedures, provide instruction by manufacturer's representatives. Include a detailed review of the following items:

1. Maintenance manuals, including a customized list of preventive maintenance items and annual schedule for maintenance.
2. Record documents.
3. Complete inventory of spare parts and materials.
4. Tools.
5. Identification systems.
6. Control sequences.
7. Hazards.
8. Cleaning.
9. Warranties and bonds.
10. Maintenance agreements and similar continuing commitments.
11. Source code and software.

B. As part of instruction for operating equipment, demonstrate the following procedures:
1. Switchgear Sequence of Operations
2. Generator and Paralleling Switchgear Sequence of Operations

3.10 INSPECTIONS

A. Contractor shall:
   1. Schedule, pay for (as applicable) and attend all inspections required by the Authorities Having Jurisdiction.

   2. Deliver all certificates to the Owner prior to final acceptance of work.

B. Notify UMB in advance of scheduled inspections.

C. An electrical foreman, superintendent or other supervisor familiar with the project shall be in attendance for all scheduled electrical inspections.

D. Electrical inspection shall be by third (3rd) Party Inspector approved by the Maryland State Fire Marshall.

E. Schedule the preliminary and rough-in inspections in a timely manner. Any work covered prior to any inspection in a manner which, in the inspector's opinion, precludes a complete inspection shall be uncovered at the installer's cost.

3.11 DEMOLITION:

A. Remove and dispose of all existing materials not required for re-use or re-installation.

B. Deliver on the premises, where directed, existing material and equipment which is to be salvaged and remain property of Owner.

C. All other materials removed shall become the property of the Contractor and shall be removed from the premises.

D. Remove conduit, hangers, supports, etc. to a point below the finished floors or behind finished walls and cap. Cut such items flush with masonry surfaces.

E. Remove wiring and conduit back to source panelboard or switch, or to last remaining device on the circuit. Remove conduit, hangers, supports, etc. unless otherwise noted. Conduit may remain to be reused for new work provided it is of the specified size and type and in condition acceptable to UMB.

F. Any conduit abandoned in concrete slabs, walls, or other inaccessible locations shall be left with a nylon pull wire. Ends shall be capped with push plugs for future use.

3.12 REPAIRS & RESTORATION OF SURFACES AND FINISHES:

A. Restore all finishes, equipment and surfaces to original condition, where affected by the work. Provide the following, where applicable, in accordance with accepted trade standards and to Owner's satisfaction:

   1. Replace damaged ceiling tiles.

2. Replace ceiling tiles where removal has left holes or cuts in original tiles.
3. Patch, repair and repaint all walls and surfaces cut, penetrated or otherwise disturbed by the work.
4. Patch holes and penetrations in wood, masonry and plaster.
5. Provide suitable cover plates for all recessed back boxes of equipment removed and not covered by new devices.
6. Provide larger trim or cover plates for new devices, where old back boxes, holes, etc. are not concealed by new work.

3.13 FINAL CLEANING

A. General: General cleaning during construction is required by the General Conditions and included in Section Temporary Facilities.

B. Cleaning: Switchgear and electrical equipment shall have a final cleaning within 30 days prior to substantial completion. Such cleaning shall be accomplished by an electrical testing firm experienced in servicing the equipment. Comply with manufacturer's instructions.

C. Remove all electrical clippings, wiring, nuts, bolts, etc. left on top of ceilings and ceiling tiles.

3.14 PROJECT PUNCH OUT

A. Architect/Engineer will perform punch out reviews and will provide the Contractor with a list of punch list items to be completed before contract close out. Each and every punch list item shall be initialed and dated by the Contractor when the work is complete. The Architect/ Engineer will not perform any punch list verification until all items have been completed, initialed, dated and the list returned to the Architect/Engineer. If any items have been initialed as being completed by the Contractor and the Architect/Engineer determines that the work is not complete, the Architect/Engineer shall be reimbursed by the Contractor at his regular hourly rate for any and all items requiring revisiting of the site by the Architect/Engineer. Reimbursement shall be made by deducting the Architect/Engineer fee from the Contractor's final payment.

END OF SECTION 260000

SECTION 260513 - MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

A. This Section includes cables and related splices, terminations, accessories and acceptance testing for 15,000 volt electrical distribution systems.

1.3 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.4 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories.

C. Samples: Sixteen (16) inch lengths of each type of cable indicated.

D. Qualification Data: For Installer and testing agency. Data submitted shall confirm that the person(s) and firm(s) listed in the "Quality Assurance" Article have demonstrated their capabilities and experience. The data shall include, but limited to a list of completed projects with project names, addresses, names of Architects and UMBs. Additional data includes:

E. Material Certificates: For each cable and accessory type, signed by manufacturers.

F. Source quality-control test reports. Certified reports of manufacturer’s design and production tests indicating compliance of cable and accessories with reference standards.

G. Field quality-control test reports. Field test reports indicating and interpreting test results relative to compliance with performance requirements specified. Include certified copies of field test reports.

H. Installation Manual: Manual shall include all data relative to installing the cables and accessories. Maximum pulling tensions, side wall pressure limitations, type of pulling devices shall all be documented within the manual.

I. Operation & Maintenance Manual: Include recommendation relating to acceptance and periodic maintenance testing and infrared scanning photometry. Recommendation shall include frequency and type of testing. Operation data shall include data of fault indicators and separable connectors and their accessories.

1.5 QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable. Submit the following within 30-days of contract award:

1. Name of individual(s) performing splicing/terminating
2. Certification of individual performing test with name and date
3. Number of years of medium voltage splicing/terminating experience
4. Proof of termination/splice of the type to be installed, under supervision of the kit manufacturer, or representative
5. Dummy splice/termination successfully tested as follows. Test to be performed by the splice kit supplier.

Test	Minimum Value
Discharge Ext. Value with, 3 pcs.	13-kV
Ac Withstand, 1 minute	35-kV
DC Withstand, 15 minutes	65-kV

6. List of three recent jobs within last twelve (12) months where specific splices/terminations were installed. Include splice/termination manufacturer, catalogue number, cable type and the quantity installed.

B. Manufacturer Qualifications: Firm experienced in manufacturing medium-voltage cable and accessories similar to those indicated for this project, with a ten (10) year record of successful in-service performance

C. Testing Agency Qualifications: In addition to the requirements specified in Division 1 Section "Quality Control Services," an independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing

laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with IEEE C2 "National Electrical Safety Code" and NFPA 70.

G. Production Tests shall be performed on the cable at time of manufacture.

1. Resistance requirements of ICEA S-68-516, section 2.5.
2. Insulation resistance test shall be performed in accordance with ICEA S-68-516, part 6.28, and shall have an insulation resistance constant of at least 50,000 megohms-1000 feet at 15^0C.
3. A high voltage ac and dc test shall be performed in accordance with part 6.27 of ICEA S-68-516. The test voltage shall be as follows:

Insulation	Wall	AC kV (5 Minutes)	DC kV (15 minutes)
115	23	45	
220	44	80	

4. The shield resistance shall be measured and recorded from end top end on the complete cable
5. The cable shall be corona discharge tested in accordance with Section G of AEIC CS^. The maximum allowable discharge is five (5) picocoulombs throughout the entire specified test voltage range.
6. Certified test reports shall be furnished to the Engineer, for review, for all cables prior to installation.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by UM or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify UM in writing no fewer than ten (10) days in advance of proposed interruption of electric service.

2. Do not proceed with interruption of electric service without written permission from – UMB PM.

3. Outages to existing loads shall occur during off hours.

   a. If contractor elects to do outages or switchovers during normal hours then contractor shall submit a plan to be approved by the owner and provide temporary power at no additional cost.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver medium voltage cable on factory reels conforming to NEMA WC 26.

B. Store cables on reels on elevated platforms in a dry location.

C. Provide hot–shrink (cold-shrink not permitted) cable end caps for cable stored outside.

1.8 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Cables:

   a. General Cable Technologies Corporation.
   b. Okonite Company (The).
   c. Pirelli Cables & Systems NA.
   d. Rome Cable Corporation.
   e. Southwire Company.

2. Cable Splicing and Terminating Products and Accessories:

   a. G&W Electric Company.
   b. Raychem Corp.; Telephone Energy and Industrial Division; Tyco International Ltd.
   c. RTE Components; Cooper Power Systems, Inc.
   d. Thomas & Betts Corporation/Elastimold.

e. 3M; Electrical Products Division.
f. Approved Equal.

3. Arc Proofing Products:

a. 3M/ Scotch Products.
b. Plymoth Bishop
c. Thomas and Betts Corporation

2.2 CABLES

A. Cable Type: MV105, single conductor insulated power cable.

B. Comply with UL 1072, AEIC CS 8, ICEA S-93-639, and ICEA S-97-682, ASTM B-8 or B-231.

C. Conductor: Copper.

D. Conductor Stranding: Compact round, concentric lay, Class B.

E. Conductor Insulation: Ethylene-propylene rubber (EPR) conforming to NEMA WC74 (ICEA S-68-516 and AEIC CS6).

1. Voltage Rating: 15 kV.
2. Insulation Thickness: 133 percent insulation level.

F. Shielding: Copper tape, helically applied over semiconducting insulation shield.
1. 25% tape overlay

G. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.

2.3 SPLICE KITS

A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.

1. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.

2.4 SOLID TERMINATIONS

A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
2. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
3. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.
4. Class 1 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.

2.5 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

C. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

D. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

E. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.

1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.

2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.

F. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.

G. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, ground cable set and carrying case.

2.6 FAULT INDICATORS

A. Indicators: Manually reset fault indicator with inrush restraint feature, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.

B. Resetting Tool: Designed for use with fault indicators, with moisture-resistant storage and carrying case.

2.7 PROTECTIVE CABLE END CAPS

A. Protect MV cables from water penetration on job site, before, during and after cable pulling. Seal cable end with heat-shrinkable end cap. This cap will remain in place until the actual time of termination. Sealing compounds and/or taping shall not constitute acceptable environmental protection. End sealing caps shall be as produced by Raychem Corporation, Type ESC, or equal.

2.8 ARC-PROOFING MATERIALS

A. Tape for First Course on Metal Objects: 10-mil- thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, compatible with cable jacket.

C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch wide.

2.9 SOURCE QUALITY CONTROL

A. Test and inspect cables according to ICEA S-97-682, NEMA WC74 before shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to manufacturer's written instructions and IEEE 576.

B. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use NRTL - listed and manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
3. Provide written calculations confirming pulling tensions and side wall pressure limits are within cable manufacturer's recommendations. Submit to Engineer prior to start of work.

C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

D. Install "buried-cable" warning tape twelve (12) inches above cables.

E. Install fault indicators on each phase where indicated.

F. In manholes, hand holes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.

G. Install cable splices at pull points and elsewhere as indicated; use standard kits.

H. Install terminations at ends of conductors with standard kits.

I. Install separable insulated-connector components as follows:

1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
2. Portable Feed-Through Accessory: Three.
3. Standoff Insulator: Three.

J. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable sheath.
2. Wrap metallic cable components with 10-mil pipe-wrapping tape.
3. Smooth surface contours with electrical insulation putty.
4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
5. Band arc-proofing tape with one (1) inch- wide bands of half-lapped, adhesive, glass-cloth tape two (2) inches o.c.

K. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

L. Identify cables according to Division 26 Section "Identification for Electrical Systems."

M. Prior to installing cables, pull a mandrel sized 1/4" less than conduit ID. Then clean each conduit with a stiff brush to remove debris.

N. Use pulling means including, fish tape, cable, rope, basket-weave wire/cable grips and pulling eyes that will not damage cable or raceways. Do not use rope hitches for pulling attachments to cable.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections: Engage an independent, testing and inspecting agency to perform the following field tests and inspections and prepare test reports at no additional cost to UM:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS and in the presence of UM personnel or authorized agent. Certify compliance with test parameters.
2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

    a. VLF high potential per IEEE 400.2-2004
    b. Shield Continuity
    c. Provide live phasing test to ensure redundant feeders are phased and synchronized
    d. If installed cable is being spliced to an existing cable, VLF Hi-Pot test shall be performed prior to it being spliced. Temporary terminations shall be used where appropriate. After splicing is complete, testing shall be performed as indicated above.

3. Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. The infrared testing shall be performed by minimum Level 1 infrared certified thermographer.

    a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice eleven (11) months after date of Substantial Completion.
    b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

B. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Remove and replace malfunctioning units and retest as specified above, listing all deficiencies and corrective actions.

END OF SECTION 260513

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

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

C. Qualification Data: For testing agency.

D. Field quality-control test reports.

E. Operation and Maintenance materials.

1.5 PROJECT CONDITIONS

A. Interruption of Existing electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify UM no fewer than 10 days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without UM's written permission.
3. Outages to existing loads shall occur during off hours.
    a. If contractor elects to do outages or switchovers during normal hours then contractor shall submit a plan to be approved by the owner and provide temporary power at no additional cost.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.7 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

1.8 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Alcan Products Corporation; Alcan Cable Division.
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.
6. The Okonite Company.
7. Belden, Inc.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN-2 and XHHW-2.

D. Multiconductor Cable: Comply with NEMA WC 70 for steel-clad cable, Type MC with ground wire.
1. Fittings: Steel

E. Color Coding:

208/120 Volts		**480/277 Volts**	
Phase	**Color**	**Phase**	**Color**
A	Black	A	Brown
B	Red	B	Orange
C	Blue	C	Yellow
Neutral	White	Neutral	Gray
Ground	Green	Ground	Green

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.4 SLEEVE SEALS

A. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one (1) of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance and conductors #4/0 and larger: Type XHHW-2, single conductors in raceway.

B. Feeders smaller than #4/0: Type THHN-THWN-2, single conductors in raceway.

C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.

D. Branch Circuits in Cable Tray: Type THHN-THWN-2, single conductors in raceway or steel-clad cable, Type MC.

E. Class 1 Control Circuits: Type THHN-THWN-2, in raceway.

F. Class 2 Control Circuits: Type THHN-THWN-2, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

G. MC Cable Installation Requirements:
   1. Install in compliance with NFPA 70.
   2. Locations: In dry wall partitions and above accessible ceilings. Do not install in masonry partitions or walls.

3. Independently support all MC Cable runs; do not piggy-back on plumbing/HVAC, lighting fixture, and/or ceiling grid supports.
4. Do not bundle more than three (3) runs together for supporting purposes.
5. MC cable shall be installed in a neat and orderly fashion using batwings type supports.
6. Minimum bend radius shall be as recommended by the manufacturer.
7. MC cable run to switches shall have a neutral conductor.
8. Cable larger than #8AWG shall not be permitted.
9. All acceptable homeruns from panels in electrical rooms shall be installed in EMT conduit to a junction box/wire trough outside electrical rooms in accessible ceiling of corridor.
10. Homeruns from panelboard to junction box outside of electrical room: wire in EMT or IMC raceway.
11. Do NOT run MC Cable in exposed locations (e.g. all open ceiling locations, Mechanical and Electrical Equipment Rooms, IT Rooms, etc.).
12. MC cable shall be secured at intervals not exceeding six (6) feet and within twelve (12) inches of every outlet box or fitting. Luminaire whips may be six (6) feet maximum without support.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve rectangle perimeter less than fifty (50) inches and no side greater than 16 inches, thickness shall be 0.052 inch.

2. For sleeve rectangle perimeter equal to, or greater than, fifty (50) inches and one (1) or more sides equal to, or greater than, sixteen (16) inches, thickness shall be 0.138 inch.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both wall surfaces.

G. Extend sleeves installed in floors three (3) inches above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

M. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for one (1) inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for one (1) inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Perform tests and inspections and prepare test reports.

C. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.

    a. Switchgear Battery Chargers

    b. Mechanical HVAC equipment

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

3. Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. The infrared testing shall be performed by minimum Level 1 infrared certified thermographer.

4.

    a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice eleven (11) months after date of Substantial Completion.
    b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

D. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

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SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

A. Section Includes:

1. UTP cabling.
2. 62.5/125-micrometer, multimode optical fiber cabling.
3. RS-485 cabling.
4. Low-voltage control cabling.
5. Control-circuit conductors.
6. Identification products.

1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. Channel Cable Tray: A fabricated structure consisting of a one (1) piece, ventilated-bottom or solid-bottom channel section.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

F. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

G. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

H. RCDD: Registered Communications Distribution Designer.

I. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal side rails, and a bottom without ventilation openings.

J. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.

K. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

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

B. Shop Drawings: For cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

1. Vertical and horizontal offsets and transitions.
2. Clearances for access above and to side of cable trays.
3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
4. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For wire and cable to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 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.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test optical fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.
   2. Test each pair of UTP cable for open and short circuits.

B. PROJECT CONDITIONS

C. Environmental Limitations: Do not deliver or install UTP and optical fiber cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.7 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Support of Open Cabling: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

   1. Velcro straps.
   2. J-hooks.

B. Cable Trays:

   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

      a. Cable Management Solutions, Inc.
      b. Chatsworth Products Inc.
      c. Cablofil Inc.

d. Cooper B-Line, Inc.
e. Cope - Tyco/Allied Tube & Conduit.

2. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by hot-dip galvanizing, complying with ASTM A 123/A 123M, Grade 0.55, not less than 0.002165 inch thick steel, steel wire mesh or aluminum.

a. Basket Cable Trays: six (6) inches wide and two (2) inches deep. Wire mesh spacing shall not exceed two (2) by four (4) inches.
b. Trough or Ventilated Cable Trays: six (6) inches wide.
c. Ladder Cable Trays: six (6) inches wide, and a rung spacing of nine (9) inches.

C. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."

1. Outlet boxes shall be no smaller than two (2) inches wide, three (3) inches high and two and one quarter (2-1/2) inches deep.

2.2 BACKBOARDS

A. Description: Plywood, fire-retardant treated, three quarters (3/4) inches by forty eight (48) inches by ninety six (96) inches. Comply with requirements for plywood backing panels in Division 06 Section "Rough Carpentry."

2.3 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Belden CDT Inc.; Electronics Division.
2. Berk- Tek; a Nexans company.
3. CommScope, Inc.
4. Mohawk; a division of Belden CDT.
5. Superior Essex Inc.
6. General Cable Company.
7. Siemon

B. Description: 22-24 AWG, solid copper conductors, 100- ohm, four (4) pair UTP, nominal impedance +/- 15%, green CMP Plenum jacket and complies with EIA/TIA 568-C Cat 6 standard
1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-C, Category 6.
3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

2.4 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Ortronics Corporation
2. Siemon Co. (The).

B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same manufacturer and the same category or higher.

C. Connecting Blocks: 110 style for Category 6. Provide blocks for the number of cables terminated on the block, plus 25% spare; integral with connector bodies, including plugs and jacks where indicated.

2.5 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Corning
2. SYSTIMAX Solutions; a CommScope, Inc. brand.
3. Optical Cable Corporation Lucent/Abaya

B. Description: Multimode, 62.5/125-micrometer, 12-fiber, nonconductive, tight buffer, OM1, optical fiber cable. Single mode, 9/125-micrometer, 12-fiber, plenum-rated, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-C for performance specifications.
3. Comply with TIA/EIA-492AAAA-A for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

   a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.

5. Maximum Attenuation: 3.50dB/km at 850 nm; 1.0dB/km at 1300 nm for OM1 multimode, 1.0 dB/km at 1310 nm; 1.0 dB/km at 1550 nm for single mode.
6. Minimum Modal Bandwidth: 200 MHz-km at 850 nm; 500 MHz-km at 1300 nm for OM1 multimode.

C. Jacket:

1. Jacket Color: Orange for multimode and yellow for single mode.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-C.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed forty (40) inches.

2.6 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Berk-Tek; a Nexans company.
2. Corning Cable Systems.
3. Siemon Co. (The).

B. Cable Connecting Hardware:

1. Comply with the Fiber Optic Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
2. Quick-connect, simplex and duplex, Type SC connectors. Insertion loss not more than 0.5 dB.

2.7 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.8 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.9 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, complying with UL 83.

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, complying with UL 83.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF, complying with UL 83.

2.10 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with requirements of NFPA 70, NEC, National Electrical Code.

2.11 IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brady Corporation.
2. HellermannTyton.

3. Kroy LLC.
4. Panduit Corp.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.12 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports, including all deficiencies and corrective measures.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools to comply with manufacturer’s recommendations.

3.2 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-B-2006.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-B-2004 for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wire ways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install vertical and horizontal cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits three (3) inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with ninety six (96) inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1-2010.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-C.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated. Terminate conductors; no cable shall contain un-terminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced.
5. Secure and support cables at intervals not exceeding thirty (30) inches and not more than six (6) inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install distribution spools.

7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Do not allow un-terminated cable to lay on floor, prior to installation. Remove and discard cable if damaged prior to and/or during installation and replace it in its entirety with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating. In the communications equipment room, install a ten (10) foot long service loop in the cable tray, on the backboard or on each end of cable.

9. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, and “Pulling Cable." Monitor cable pull tensions and ensure manufacturer’s specified tension limits are not exceeded.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Install 110-style IDC termination hardware unless otherwise indicated.
3. Do not untwist UTP cables more than one half (1/2) inch from the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

E. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.

F. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of eight (8) inches above ceilings by cable supports not more than sixty (60) inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data 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 five (5) inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of twelve (12) inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of twenty four (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 two and one half (2-1/2) inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of six (6) inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of twelve (12) inches.

4. Separation between communications cables in grounded metallic raceways and 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 three (3) inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of six (6) inches.

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of forty eight (48) inches.
6. Separation between Cables and Fluorescent Fixtures: A minimum of five (5) inches.

3.4 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits, No 12 AWG.

3.5 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling according to TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement

Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical Fiber Cable Tests:

   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   b. Link End-to-End Attenuation Tests:

      1) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to TIA/EIA-526-14-A, Method B, one Reference Jumper.
      2) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 260523

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SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

A. Section includes grounding systems and equipment, plus the following special applications:
   1. Underground distribution grounding.
   2. Ground bonding common with lightning protection system.

1.3 SUBMITTALS

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

B. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

   1. Test wells.
   2. Ground rods.
   3. Ground rings.
   4. Grounding arrangements and connections for separately derived systems.
   5. Grounding for sensitive electronic equipment, i.e., computer and office equipment.
   6. Grounding for UPS’, batteries and related equipment.
   7. Grounding for Generators, transfer switches and related equipment.
   8. Grounding for HVAC, pumps and related equipment.
   9. Grounding for Lightning Protection System.

C. Qualification Data: For qualified testing agency and testing agency's field supervisor.

D. Field quality-control reports.

E. Operation and Maintenance Data: In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, and grounding connections for separately derived systems shall be based on NFPA 70B.

    a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
    b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

A. Independent Testing Agency Qualifications: Member Company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 467 for grounding and bonding materials and equipment.

1.5 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper or Tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; one and five eights (1-5/8) inches wide and one sixteenth (1/16) inch thick.

6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; one and five eights (1-5/8) inches wide and one sixteenth (1/16) inch thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, one quarter (1/4) by four (4) inches in cross section, with nine thirty seconds (9/32) inch holes spaced one and one eighth (1-1/8) inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.2 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression -type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; three quarter (3/4) inch in diameter by ten (10) feet long.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Equipment Grounding Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Grounding Electrode Conductors: Install bare tinned copper conductor, No. 2/0 AWG minimum.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal

inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers two (2) inches minimum from wall, six (6) inches above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.

E. Ground Ring: Install a ground ring around the perimeter of the building or structure. Bond the ring in accordance with the National Electrical Code.

F. Concrete Encase Electrode: Install a concrete encased electrode as part of the building's or structure's foundation. Bond the electrode in accordance with the National Electrical Code.

G. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so four (4) inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from two (2) inches above to six (6) inches below concrete. Seal floor opening with waterproof, nonshrink grout. Exposed grounding conductors pulled through manholes shall also be bonded to the ground rod in each manhole.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or

plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than six (6) inches from the foundation.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
10. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components. Ground fault protection is required on heat tracing and anti-frost heating circuits.

D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

F. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a one quarter (1/4) inch by four (4) inch by twelve (12) inch grounding bus.
3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

G. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode, grounding electrode conductor and a separate insulated equipment grounding conductor installed with branch-circuit conductors.

3.4 INSTALLATION

A. Grounding Electrode and Equipment Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are two (2) inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.

2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least twelve (12) inches deep, with cover.

1. Test Wells: Install at least one (1) test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than sixty (60) feet apart.

I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.

1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than thirty (30) inches from building's foundation.

J. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70; use a minimum of twenty (20) feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than twenty (20) feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.5 LABELING

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.

1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Contractor to engage a third (3rd) Party qualified independent testing agency approved by the Maryland State Fire Marshall to perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells. Make tests at ground rods before any conductors are connected.

   a. Measure ground resistance no fewer than two (2) full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
   b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).
5. Substations and Pad-Mounted Equipment: 5 ohms.
6. Manhole Grounds: 10 ohms.
7. Maximum ground-resistance value 5 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify UMB promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.8 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.

c. ERICO International Corporation.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Tyco International, Ltd.
g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Hilti Inc.
2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
3) MKT Fastening, LLC.
4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Cooper B-Line, Inc.; a division of Cooper Industries.

2) Empire Tool and Manufacturing Co., Inc.
3) Hilti Inc.
4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

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

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

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

SUMMARY

B. Related Sections include the following:

1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.2 DEFINITIONS

A. RMC: Rigid metallic conduit.

B. PVC/RMC: PVC coated rigid metallic conduit.

C. EMT: Electrical metallic tubing.

D. EPDM: Ethylene-propylene-diene terpolymer rubber.

E. FMC: Flexible metal conduit.

F. LFMC: Liquidtight flexible metal conduit.

G.

H. NBR: Acrylonitrile-butadiene rubber.

I. RNC: Rigid nonmetallic conduit.

1.3 SUBMITTALS

A. Product Data: For raceways, wire ways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. Custom enclosures and cabinets include layout drawings showing components and wiring.

C. Coordination Drawings: Conduit routing 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. Structural members in the paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

D. Source quality-control test reports.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access and eliminate interference problems.

1.5 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. AFC Cable Systems, Inc.
2. Alflex Inc.

3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. O-Z Gedney; a unit of General Signal.
7. Wheatland Tube Company.

B. Rigid Steel Conduit: ANSI C80.1.

C. EMT: ANSI C80.3.

D. FMC: Zinc-coated steel.

E. LFMC: Flexible steel conduit with PVC jacket.

F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
2. Fittings for EMT: Steel [compression] type.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

G. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. AFC Cable Systems, Inc.
2. Arnco Corporation.
3. CertainTeed Corp.; Pipe & Plastics Group.
4. Lamson & Sessions; Carlon Electrical Products.
5. Manhattan/CDT/Cole-Flex.
6. RACO; a Hubbell Company.
7. Thomas & Betts Corporation.

B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

C. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

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

1. Arnco Corporation.
2. Endot Industries Inc.
3. IPEX Inc.
4. Lamson & Sessions; Carlon Electrical Products.

B. Description: Comply with UL 2024; flexible type, approved for plenum [riser] general-use installation.

2.4 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type. Secured with stainless steel screws.

E. Finish: Manufacturer's standard enamel finish.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Hoffman.
4. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
5. O-Z/Gedney; a unit of General Signal.
6. Robroy Industries, Inc.; Enclosure Division.
7. Scott Fetzer Co.; Adalet Division.

8. Spring City Electrical Manufacturing Company.
9. Thomas & Betts Corporation.
10. Walker Systems, Inc.; Wiremold Company (The).

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

D. Exterior and Wet locations
1. Cast aluminum or galvanized cast iron type.
2. Threaded hubs.
3. Gasket screw-on cover plates
4. NEMA FB-1

E. Boxes embedded in concrete
1. NEMA 4X PVC
a. Glue-in conduit hubs
b. Gasket cover plates
c. Sunlight UV resistant

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic finished inside with radio-frequency-resistant paint.

H. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.6 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.7 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: RMC.
2. Concealed Conduit, Aboveground: RNC, Type EPC-40-PVC.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R or 4.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Office Spaces: EMT.
2. Conduits > 2”: Rigid Steel.
3. All wiring > than 600 volts: Rigid Steel.

4. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:

   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical and Electrical rooms and IT Rooms/Closets.

5. Concealed in Ceilings and Interior Walls and Partitions: EMT.
6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
7. Damp or Wet Locations: Rigid steel conduit.
8. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
9. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: EMT.
10. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.
11. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: Three quarter (3/4) inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least six (6) inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Change from RNC to rigid steel conduit before rising above the floor.

I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least twelve (12) inches of slack at each end of pull wire.

L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:

1. Three quarter (3/4) Inch Trade Size and Smaller: Install raceways in maximum lengths of fifty (50) feet.
2. One (1) Inch Trade Size and Larger: Install raceways in maximum lengths of seventy five (75) feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

N. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30^0F, and that has straight-run length that exceeds 25 feet.

1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:

   a. Outdoor Locations Not Exposed to Direct Sunlight: 125^0F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155^0F temperature change.
   c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125^0F temperature change.
   d. Attics: 135^0F temperature change.

2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per ^{0}F of temperature change.
3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

O. Flexible Conduit Connections: Use maximum of seventy two (72) inches of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC in damp or wet locations not subject to severe physical damage.

P. Set metal floor boxes level and flush with finished floor surface.

Q. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve cross-section rectangle perimeter less than fifty (50) inches and no side greater than 16 inches, thickness shall be 0.052 inch.
2. For sleeve cross-section rectangle perimeter equal to, or greater than, fifty (50) inches and one (1) or more sides equal to, or greater than, sixteen (16) inches, thickness shall be 0.138 inch.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both surfaces of walls.

G. Extend sleeves installed in floors two (2) inches above finished floor level.

H. Size pipe sleeves to provide one quarter (1/4) inch annular clear space between sleeve and raceway unless sleeve seal is to be installed or unless seismic criteria require different clearance.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using 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.

3.4 SLEEVE-SEAL INSTALLATION

A. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.6 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

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SECTION 260536 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

A. This Section includes aluminum cable trays and accessories.

1.3 SUBMITTALS

A. Product Data: Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

C. Coordination Drawings: Floor plans and sections, drawn to scale. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements. Show the following:

1. Vertical and horizontal offsets and transitions.
2. Clearances for access above and to side of cable trays.
3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.

D. Field quality-control reports.

E. Operation and Maintenance Data: For cable trays to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain cable tray components through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store indoors to prevent water or other foreign materials from staining or adhering to cable tray. Unpack and dry wet materials before storage.

1.6 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Cooper B-Line, Inc.
2. Cope, T. J., Inc.; a subsidiary of Allied Tube & Conduit.
3. GS Metals Corp.; GLOBETRAY Products.
4. MONO-SYSTEMS, Inc.
5. MPHusky.
6. PW Industries.

2.2 MATERIALS AND FINISHES

A. Cable Trays, Fittings, and Accessories: Steel, complying with NEMA VE 1.

1. Hot-dip galvanized after fabrication, complying with ASTM A 123/A 123M, Class B2; with chromium-zinc, ASTM F 1136, hardware.

B. Sizes and Configurations:

1. Ladder Type (Vertical Risers Only): Ladder type transverse rungs welded to side rails shall be 9 inches on center. Rungs shall have a minimum bearing surface of 3/4 inch radius edges.

2. Ventilated Trough Type: Corrugated trough bottoms shall be welded to the side rails and have a minimum cable bearing surface of 2-3/4 inches on [6[[9] inch centers. Ventilation holes (2-1/4 inch x 4 inch) shall be punched along the width of the valleys.

3. Dimensions:

   a. Tray width shall be as shown on drawings.
   b. Side rails height inches/cable fill depth shall be [6/5inches.

2.3 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

   1. Horizontal and vertical pivot splice blocks, connectors, as required.

   2. Manufacturer's stiffener bars installed on all eighteen (18) inch wide sections to stabilize tray when loaded unevenly.

B. Barrier Strips: Same materials and finishes as cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.4 WARNING SIGNS

A. Lettering: 1-1/2-inch- high, black letters on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

B. Materials and fastening are specified in Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Perform design and production tests according to NEMA FG 1 NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Comply with recommendations in NEMA VE 2. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, barrier strips, hinged horizontal and vertical splice plates, elbows, reducers, tees, and crosses.

B. Remove burrs and sharp edges from cable trays.

C. Fasten cable tray supports to building structure.

1. Place supports so that spans do not exceed manufacturer's maximum spans.
2. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
3. Support bus assembly to prevent twisting from eccentric loading.
4. Manufacture center-hung support, designed for 60% versus 40% eccentric loading condition, with a safety factor of three (3).
5. Locate, design and install supports according to NEMA FG 1 NEMA VE 1, or the calculated load multiplied by a safety factor of four (4), or the calculated load plus two hundred (200) lbs (90 kg) whichever is the greater.

D. Retain paragraph below if cable tray connects to equipment. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independent of fittings. Do not carry weight of cable tray on equipment enclosure.

E. Retain first paragraph below if expansion fittings are required. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed dimensions recommended in NEMA FG 1 NEMA VE 1. Space connectors and set gaps according to applicable standard.

F. Make changes in direction and elevation using standard fittings.

G. Make cable tray connections using standard fittings.

H. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."

I. Sleeves for Future Cables: Install capped sleeves for (25% growth) future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

J. Workspace: Install cable trays with minimum eighteen (18) inches above tray to permit access for installing cables.

K. Install barriers to separate cables of different systems, such as power, communications, and data processing. Mixing 600, 5,000 and 15,000 systems in the same cable tray is not permitted.

L. After installation of cable trays is completed, install warning signs in visible locations on or near cable trays.

3.2 CABLE INSTALLATION

A. Install cables only when cable tray installation has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties as recommended by NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. On vertical runs, fasten cables to tray every eighteen (18) inches. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

D. In existing construction, remove inactive or dead cables from cable tray.

E. Install covers after installation of cable is completed. Delete this

3.3 CONNECTIONS

A. Ground cable trays according to manufacturer's written instructions.

B. Install an insulated equipment grounding conductor with cable tray, in addition to those required by NFPA 70.

C. Install insulated bonding jumper cable, sized per NEC, between bolted connections.

3.4 FIELD QUALITY CONTROL

A. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements. Perform the following field quality-control survey:

1. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable tray, vibration, and thermal expansion and contraction conditions, which may cause or have caused damage.
2. Verify that the number, size, and voltage of cables in cable tray do not exceed that permitted by NFPA 70. Verify that communication or data-processing circuits are separated from power circuits by barriers.

3. Verify that there is no intrusion of such items as pipe, hangers, or other equipment that could damage cables.
4. Remove deposits of dust, industrial process materials, trash of any description, and any blockage of tray ventilation.
5. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
6. Check for missing or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
7. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable tray.

B. Report results in writing.

3.5 PROTECTION

A. Protect installed cable trays.

1. Repair damage finishes with methods and products as recommended by cable tray manufacturer.
2. Install temporary protection for cables in open trays to protect exposed cables from falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials until the risk of damage is over.

END OF SECTION 260536

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product specified in this section.

B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.

1.4 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than fifty (50) inches and with no side larger than sixteen (16) inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter fifty (50) inches or more and one or more sides larger than sixteen (16) inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Presealed Systems.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5,000-psi, twenty eight (28) day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Silicone Foams: Multi-component, silicone-based, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
b. Seal space outside of sleeves with mortar, grout or silicone. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide one quarter (1/4) inch annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. De-burr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors two (2) inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work to maintain any existing warranties

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using PVC or 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.

G. Underground, Exterior-Wall and Floor Penetrations: Install PVC or steel pipe sleeves. Size sleeves to allow for one (1) inch annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

3.2 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.

3.3 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.

END OF SECTION 260544

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SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

1.6 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. LEM Products, Inc.
2. Panduit Corp.
3. Brady
4. Approved Equal

2.2 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.

2. Legend: Indicate voltage and system or service type.

C. Colors for Raceways Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high letters on twenty (20) inch centers.

D. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

E. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: four (4) inch- wide black stripes on ten (10) inch centers diagonally over orange background that extends full length of raceway or duct and is twelve (12) inches wide. Stop stripes at legends.

2.3 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Colors for Raceways Carrying Circuits at 600 V and Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Colors for Raceways Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with three (3) inch- high letters on twenty (20) inch centers.

D. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.4 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Colored Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label. Tape shall not be less than 3 mils thick by 1 inch wide.

2.5 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3- mils thick by one (1) to two (2) inches wide.

2.6 FLOOR MARKING TAPE

A. Two (2) inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.7 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for “RED”-Colored Tapes: “ELECTRIC LINE, HIGH VOLTAGE”.
3. Inscriptions for “ORANGE”-Colored Tapes: “TELEPHONE CABLE”, “CATV CABLE”, “COMMUNICATIONS CABLE”, “OPTICAL FIBER CABLE”.

C. Tag: Type I:

1. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Thickness: 4 mils.
3. Weight: 18.5 lb/1000 sq. ft.
4. Three (3) Inch Tensile According to ASTM D 882: 30 lbf, and 2,500 psi.

2.8 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Interior Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. One quarter (1/4) inch grommets in corners for mounting.
3. Nominal size, seven (7) inches by ten (10) inches.

C. Exterior Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. One quarter (1/4) inch grommets in corners for mounting.
3. Nominal size, ten (10) inches by fourteen (14) inches.

D. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.9 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum one sixteenth (1/16) inch thick for signs up to twenty (20) sq. inches and one eighth (1/8) inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
4. Minimum letter height shall be three eighth (3/8) inch.

2.10 EQUIPMENT IDENTIFICATION LABELS

A. Stenciled Legend: In non-fading, waterproof, black ink or paint. Minimum letter height shall be one (1) inch.

2.11 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one (1) piece, self locking, Type 6/6 nylon.

1. Minimum Width: Three sixteenth (3/16) inch.

2. Tensile Strength at 73ºF, According to ASTM D 638: 12,000 psi.
3. Temperature Range: -40ºF to + 185ºF.
4. Color: "BLACK" except where used for color-coding.

2.12 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two (2) color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at fifty (50) foot maximum intervals in straight runs, and at twenty five (25) foot maximum intervals in congested areas. List typical color codes for systems, i.e. fire alarm, "RED"; security, "BLUE" and "YELLOW"; etc.

G. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at six (6) inches to eight (8) inches

below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds sixteen (16) inches overall.

I. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Concealed Raceways, Duct Banks, more than 600 V, within Buildings: Tape and stencil four (4) inch wide black stripes on ten (10) inch centers over orange background that extends full length of raceway or duct and is twelve (12) inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with three (3) inch- high black letters on twenty (20) inch centers. Stop stripes at legends. Apply to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within twelve (12) inches of a floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to raceways concealed within wall.
3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Self-adhesive vinyl labels. Install labels at ten (10) foot maximum intervals.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label. Install labels at ten (10) foot maximum intervals.

D. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall include panel and circuit information.

1. Emergency Power – “RED”
2. UPS
3. Fire Alarm System – “RED”
4. Fire-Suppression Supervisory and Control System – “RED” and “YELLOW”
5. Security – “BLUE” and “YELLOW”
6. Mechanical and Electrical Supervisory Systems – “GREEN” and “BLUE”
7. Telecommunication System – “ORANGE” and “YELLOW”
8. Control Wiring – “GREEN” and “RED”

E. Power-Circuit Conductor Identification, 600 V or Less: For conductors 1/0 and larger in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor

tape to identify the source and circuit number for each set of conductors. For single phase conductors, identify each phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded feeder and branch-circuit conductors.

    a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG.

    b. Colors for 208/120-V Circuits:

        1) Phase A: "BLACK".
        2) Phase B: "RED".
        3) Phase C: "BLUE".

    c. Colors for 480/277-V Circuits:

        1) Phase A: "BROWN".
        2) Phase B: "ORANGE".
        3) Phase C: "YELLOW".

F. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of six (6) inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

G. Install instructional sign including color-code for grounded and ungrounded conductors using adhesive-film-type labels.

H. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

J. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.

2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

K. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

L. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

a. Power transfer switches.
b. Controls with external control power connections.
c. DC Panelboards

M. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

N. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum three eighths (3/8) inch- high letters for emergency instructions at equipment used for power transfer and/or load shedding.

O. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Engraved, laminated acrylic or melamine label or Stenciled legend 4 inches high. Unless otherwise indicated, provide a single line of text with one half (1/2) inch high letters on one and one half (1-1/2) inch- high label; where two (2) lines of text are required, use labels two (2) inches high.
b. Outdoor Equipment: Stenciled legend four (4) inches high.

c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be laminated acrylic or melamine label.
b. Enclosures and electrical cabinets - laminated acrylic or melamine labels.
c. Access doors and panels for concealed electrical items laminated acrylic or melamine labels.
d. Switchgear – stencil and paint
e. Switchboards – stencil and paint
f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary – stencil and paint.
g. Substations – stencil and paint.
h. Emergency system boxes and enclosures – stencil and paint.
i. Motor-control centers – stencil and paint.
j. Enclosed switches – laminated acrylic or melamine label.
k. Enclosed circuit breakers – laminated acrylic or melamine label.
l. Enclosed controllers – laminated acrylic or melamine label.
m. Variable-speed controllers – laminated acrylic or melamine label.
n. Push-button stations – laminated acrylic or melamine label.
o. Power transfer equipment – laminated acrylic or melamine label.
p. Contactors – laminated acrylic or melamine label.
q. Remote-controlled switches, dimmer modules, and control devices – laminated acrylic or melamine label.
r. Battery-inverter uni – laminated acrylic or melamine label
s. Battery racks – laminated acrylic or melamine label. Power-generating units – stencil and paint.
t. Communication Cabinets/Racks – laminated acrylic or melamine label.
u. Security Cabinets – laminated acrylic or melamine label.
v. Fire Alarm and Annunciator Cabinets – laminated acrylic or melamine label.
w. Control System Cabinets – laminated acrylic or melamine label.
x. Monitoring and control equipment – laminated acrylic or melamine label.
y. UPS equipment – laminated acrylic or melamine label.
z. Each receptacle, light switches and receptacles mounted in surface raceways shall be neatly marked on the inside cover with indelible marker identifying the panel and breaker from which it is fed and durable markers or tag inside outlet box. This to ensure the correct covers are restored after

room renovations and/or painting. In addition to marking circuit identification inside the cover, also provide laminated label with circuit number on device cover plates. Provide white background label with black bold lettering.

END OF SECTION 260553

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SECTION 260800 – COMMISSIONING ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section and all other sections of Division 26.

B. The OPR and BOD documentation are included by reference for information only.

1.2 SUMMARY

A. This section includes the requirements for commissioning the electrical systems, assemblies and equipment.

B. System Description: The CxA will be responsible for developing pre-functional checklists and Functional Performance Test scripts for the entire electrical system. The test scripts should not only include the individual equipment but the interaction of the entire system. The CxA shall coordinate with the Owner to develop limitations to building outages and incorporate these limitations into the commissioning plan.

1.3 DESCRIPTION

A. The following equipment and/or accessories shall be commissioned as part of this project:

1. Medium Voltage Service Electrical Systems.
2. Secondary Service Electrical Systems.
3. Distribution and Branch Circuit Panelboards.
4. Exterior Lighting Fixtures and Controls.
5. Equipment Monitoring/Metering and Alarm System.
6. AC Motors.
7. Grounding Equipment and Building Grounding System.
8. Security System.
9. Emergency Generators and Distribution System.
10. Switchgear Control System

1.4 SUBMITTALS

A. Refer to Division 01 Section "General Commissioning Requirements" for CxA's role.

B. Refer to Division 01 Section "Submittal Procedures" for specific requirements. Refer to Division 01 Section "General Commissioning Requirements" for additional submittal requirements related to submittals of equipment to be commissioned and Cx specific submittals.

1.5 COORDINATION

A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to coordination during the commissioning process.

1.6 GENERAL DOCUMENTATION

A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for all commissioned components, equipment, and systems.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to testing equipment.

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify in writing to the CxA that electrical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Place systems, subsystems, and equipment into operating mode to be tested.

C. Inspect and verify the position of each device and interlock identified on checklists.

D. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of electrical testing shall include lighting controls and power riser inspections.

C. Test all operating modes and verify proper response of controllers and sensors.

D. The CxA along with the lighting contractor shall prepare detailed testing plans, procedures, and checklists for applicable lighting systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

3.3 ELECTRICAL SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Procedures: Where applicable follow manufacturer's written procedures. If no procedures are prescribed by the manufacturer, proceed as follows:

1. Electrical Distribution Systems: Includes panels and circuit breakers for power and lighting.

   a. Verify that all panels and components have been installed correctly, are accessible and operate as intended.
   b. Verify that specified tests are complete.

2. Electrical Equipment: Includes lighting controls, emergency generator, and automatic transfer switch,.

   a. Verify that all equipment has been installed in accordance with the manufactures recommendations and all equipment can be easily accessed for maintenance and operates as intended.
   b. Verify that all connections, controls, and accessories have been installed correctly and operates as intended.
   c. Verify that all equipment test, training, and startup procedures have been completed per the specifications.
   d. Operate equipment as intended to ensure the design conditions can be obtained.

END OF SECTION 260800

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SECTION 260913 - ELECTRICAL POWER MONITORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

A. Section includes the following for monitoring and control of electrical power system:

1. Communication network and interface modules for RS-485, Modbus TCP/IP and IEEE 802.3 data transmission protocols.
2. Power monitoring equipment (Power Monitors).
3. Programming and Software.

B. This specification contains hardware and software requirements for the metering network only. For the switchgear and generator control systems refer to specification 262313 Switchgear Control System. The metering system shall provide remote and local monitoring of the system only. The metering system shall receive input from the control system but the control system shall not accept input from the metering system. The metering system shall not have control capability of any switchgear. The metering system will communicate over the campus network. The switchgear control system shall communicate over a new dedicated network provided under this project.

C. The campus has an existing Square D metering software package (EcoStruxure Power Monitoring Expert (PME)) that monitors the electric meters throughout the campus. This software system shall be updated to the latest version and also updated to include the new meters that are being provided on campus. In addition, the contractor shall contract with Square D to update the metering software to include single line representations of the North Switching Station, Howard Hall 15kV Switchgear, Howard Hall 15kV Generator Switchgear, Howard Hall 480V Switchgear, and the BRB 480V Switchgear. The system shall be expandable to include the future South Switching Station.

1.3 DEFINITIONS

A. Ethernet: Local area network based on IEEE 802.3 standards.

B. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.

C. HTML: Hypertext markup language.

D. I/O: Input/output.

E. KY Pulse: A term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay changing status in response to the rotation of the disk in the meter.

F. LAN: Local area network; sometimes plural as "LANs."

G. LCD: Liquid crystal display.

H. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or remote-control, signaling and power-limited circuits.

I. Modbus TCP/IP: An open protocol for exchange of process data.

J. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

K. PC: Personal computer; sometimes plural as "PCs."

L. rms: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

M. RS-232: A TIA standard for asynchronous serial data communications between terminal devices.

N. RS-485: A TIA standard for multipoint communications using two twisted-pairs.

O. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

P. THD: Total harmonic distortion.

Q. UPS: Uninterruptible power supply; used both in singular and plural context.

R. WAN: Wide area network.

1.4 ACTION SUBMITTALS

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

1. Attach copies of approved Product Data submittals for products (such as switchboards and switchgear) that describe power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.

B. Shop Drawings: For power monitoring and control equipment. Include plans, elevations, sections, details, and attachments to other work.

1. Outline Drawings: Indicate arrangement of components and clearance and access requirements.
2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

C. Other Informational Submittals:

1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power monitoring and control units, to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Operating and applications software documentation.
2. Software licenses.
3. Software service agreement.
4. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.

5. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.

B. Software and Firmware Operational Documentation:

C. Software licenses and upgrades required by and installed for operating and programming digital and analog devices.

1.7 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. Addressable Relays: One for every 10 installed. Furnish at least one of each type.
2. Data Line Surge Suppressors: One for every 10 of each type installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Manufacturer Qualifications: A firm experienced in manufacturing power monitoring and control equipment similar to that indicated for this Project and with a record of successful in-service performance.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.9 COORDINATION

A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.

1. Match components and interconnections for optimum performance of specified functions.

B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

1.10 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Through Schneider Electric, provide two (2) years of PowerLogic Technical Support for the UMB Power Monitoring Expert (PME) electrical metering system that will begin on the project's date of substantial completion.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include the operating systems. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.11 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by Schneider Electric – Power Management Operation.

2.2 FUNCTIONAL DESCRIPTION

A. Software: Existing Square D software shall be updated to include trending of all new meters on this project. In addition, new schematic representations showing single line drawings with breaker status, and alarm conditions, such as breaker trips, shall be provided for the North Switching Station, Howard Hall 15kV SWGR, Howard Hall 15kV Generator SWGR, Howard Hall 480V SWGR, and BRB 480V SWGR. All new meters will tie into the existing campus communication network.

1. Contractor shall contact Square D for work involving upgrading existing Power Monitoring system. Square-D Owner Representative is: Jeff Pitzer, jeff.pitzer@schneider-electric.com. 717-495-2507.

2.3 SYSTEM REQUIREMENTS

A. Existing Server: Existing server is located in the Health Sciences Library. Server shall be updated to include all new meters and workstations.

2.4 POWER MONITORING EQUIPMENTCIRCUIT MONITORS – Advanced (ION 7400 & ION 9000T with small screen display)

1. Measured Values

a) The following metered values shall be measured by the Circuit Monitor. In addition, the circuit monitor shall record and save in nonvolatile memory the minimum and maximum values of all listed values since last reset. The circuit monitor shall also record and save in nonvolatile memory the interval minimum, maximum, and average of any of the values pre-defined over a user specified interval.

1) Real-Time Readings

(a) Current (Per-Phase, N, G, 3-Phase Avg, Apparent rms, %Unbalanced)
(b) Voltage (L–L Per-Phase, L-L 3-Phase Avg, L–N Per-Phase, 3-Phase Avg, Neutral to Ground, % unbalanced)
(c) Real Power (Per-Phase, 3-Phase Total)
(d) Reactive Power (Per-Phase, 3-Phase Total)
(e) Apparent Power (Per-Phase, 3-Phase Total)
(f) Power Factor (True)(Per-Phase, 3-Phase Total)
(g) Power Factor (Displacement)(Per-Phase, 3-Phase Total)
(h) Frequency
(i) Temperature (Internal Ambient)
(j) THD (Current and Voltage)
(k) K-Factor (Per-Phase)

2) Energy Readings

(a) Accumulated Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute)
(b) Incremental Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute)
(c) Conditional Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute)
(d) Reactive Energy by Quadrant

3) Demand Readings

(a) Demand Current (Per-Phase present, 3-Phase Avg, Neutral)

(i) Last complete interval

(ii) Peak

(b) Demand Voltage (L-N, L-L, Per-Phase, 3-Phase avg.)

(i) Last complete interval
(ii) Minimum
(iii) Peak

4) Average Power Factor (True), (3-Phase total)

(a) Last complete interval
(b) Coincident with kW peak
(c) Coincident with kVAR peak
(d) Coincident with kVA peak

5) Demand Real Power (3-Phase Total)

(a) Last complete interval
(b) Predicted
(c) Peak
(d) Coincident kVA Demand
(e) Coincident kVAR Demand

6) Demand Reactive Power (3-Phase Total)

(a) Last complete interval
(b) Predicted
(c) Peak
(d) Coincident kVA demand
(e) Coincident kW demand

7) Demand Apparent Power (3-Phase Total)

(a) Last complete interval
(b) Predicted
(c) Peak
(d) Coincident kVA demand
(e) Coincident kW demand

8) Power Analysis Values

(a) THD – Voltage, Current (3-Phase, Per-Phase, Neutral)
(b) THD - Voltage, Current (3-Phase, Per-Phase, Neutral)
(c) Total Demand Distortion
(d) K-Factor (Per-Phase)
(e) Crest Factor (Per-Phase)
(f) Displacement Power Factor (Per-Phase, 3-Phase)
(g) Fundamental Voltage, Magnitude and Angle (Per-Phase)

(h) Fundamental Currents, Magnitude and Angle (Per-Phase)
(i) Fundamental Real Power (Per-Phase, 3-Phase)
(j) Fundamental Reactive Power (Per-Phase)
(k) Harmonic Power ((Per-Phase, 3-Phase)
(l) Phase Rotation
(m) Unbalance (Current and Voltage)
(n) Harmonic Magnitudes & Angles (Per-Phase)
(o) Distortion Power
(p) Distortion Power Factor

b) The current and voltage signals shall be digitally sampled at a rate high enough to provide true rms accuracy to the 255th harmonic (based on fundamental of 50/60 Hz).

c) The following metered values as well as the minimum and maximum instantaneous readings since last reset shall be communicated by the Circuit Monitor:

1) Frequency
2) Temperature
3) Current, per phase rms and neutral (if applicable)
4) Current, 3-phase average rms
5) Current, apparent rms
6) Voltage, phase-to-phase and phase-to-neutral
7) Voltage unbalance, phase-to-phase and phase-to-neutral
8) Power factor, per phase
9) Power factor, 3-phase total
10) Real power, per phase and 3-phase total
11) Reactive power, per phase and 3-phase total
12) Apparent power, per phase and 3-phase total
13) Demand current, per phase and three-phase average
14) Demand real power, three-phase average
15) Demand reactive power, three-phase average
16) Demand apparent power, three-phase average
17) Accumulated energy, (MWh, MVAH, and MVARh)
18) Reactive energy, (VARh by quadrant)
19) Total Harmonic Distortion (THD), voltage and current, per phase
20) K-factor, per phase

2. Demand

a) All power demand calculations shall be done by any one of the following calculation methods, selectable by the user:

1) Thermal demand is calculated using a sliding window and is updated every second. The sliding window length shall be defined by the user from one (1) minute to sixty (60) minutes, with one (1) minute increments.
2) Block interval, with optional sub-intervals. The window length shall be set by the user from one minute (1) to sixty (60) minutes in one (1) minute intervals. The user shall be able to set the sub-interval length from one (1) minute to thirty (30) minutes in one (1) minute intervals.
3) External Pulse Synchronization, utilizing a synch pulse provided externally. An optional status input shall be used to sense the pulse.
4) Sliding block interval with continuous sliding one (1) second subintervals.

b) The default demand calculation method shall be a fifteen (15) minute continuous sliding block.
c) The following demand readings shall be reported by the Circuit Monitor:

1) Average demand current, per phase
2) Peak demand current, per phase
3) Average demand for real power, reactive power, and apparent power
4) Predicted demand for real power, reactive power, and apparent power
5) Peak demand for real power, reactive power, and apparent power

d) The Circuit Monitor shall also provide a generic demand capability to provide demand calculation on any metered parameter.
e) Each Circuit Monitor shall be capable of receiving a broadcast message over the communications network that can be used to synchronize demand calculations by several Circuit Monitors. This message need not be addressed specifically to any one Circuit Monitor.

3. Sampling

a) The current and voltage signals shall be digitally sampled at a rate high enough to provide true rms accuracy to the 255th harmonic (fundamental of 60 Hz).

4. Harmonics

a) Advanced harmonic information shall be available via the Circuit Monitor. This shall include the calculation of the harmonic magnitudes and angles for each phase voltage and current through the 255th harmonic.

b) This information shall be available for all three phases, current and voltage, plus the neutral current. To ensure maximum accuracy for analysis, the current and voltage information for all phases shall be obtained simultaneously from the same cycle.
c) The Circuit Monitor shall have a minimum of 16k of on board memory to log harmonic magnitudes and angles.
d) The harmonic magnitude shall be reported as a percentage of the fundamental or as a percentage of any Circuit Monitor may be applied in three-phase, three- or four-wire systems. A fourth CT input shall be available to measure neutral or ground current. If the fourth CT is not used, then a residual current shall be calculated by vectoral addition of the phase currents. In four-wire connections the Circuit Monitor shall utilize the circuit neutral common reference and not earth ground, to provide metering accuracy.
e) Harmonic power flows will be provided up to the 41st harmonic for real, reactive and apparent power.

5. Transients

a) The Circuit Monitor shall be able to detect and capture transients up to 10,000 Vpeak line to line with a duration as short as two hundred (200) nanoseconds when equipped with a Transient Module.

6. Flicker

a) The Circuit Monitor shall detect and measure the flicker (50Hz or 60Hz) of an electrical system based on the IEC Standard 61000-4-15 (or IEEE 1453) when equipped with a Transient Module.
b) The Circuit Monitor shall measure three levels of Flicker:

1) Instantaneous
2) Short-term
3) Long-term

c) The user shall have the ability to view the graphical time-trend of Flicker magnitude in a semi-logarithmic format when equipped with a communications card.

7. EN50160 Evaluation

a) The Circuit Monitor shall include EN50160 evaluations. This capability is characterized by the evaluation of certain power quality parameters: frequency, magnitude of the supply voltage, supply voltage variations, rapid voltage changes, supply voltage dips, short interruptions of the supply voltage, long interruptions of the supply voltage, temporary power frequency overvoltages, transient overvoltages, supply voltage unbalance, and harmonic voltage.

b) The Circuit Monitor shall be capable of reporting EN50160 evaluation data in the following formats: summary of active evaluations, summary of evaluation status, detailed information for each evaluated parameter, detailed information for each abnormal event

c) The user shall be able to reset EN50160 evaluations statistics as required.

8. Accuracy

a) The Circuit Monitors shall accept metering inputs of up to 600Vac direct connection or from industry standard instrument transformers (120 VAC secondary PTs and 5 A secondary CTs). Connection to 480Y/277 VAC circuits shall be possible without use of PTs.

b) PT primaries through 1.2 MV shall be supported

c) CT primaries through 32 kA shall be supported

d) The Circuit Monitor shall be accurate to 0.04% of reading plus/minus 0.025% of full scale for voltage and current metering and 0.08% of reading plus 0.025% for power.

e) The Circuit Monitor's energy readings shall meet the revenue accuracy requirements of ANSI C12.20 0.2 class and IEC 60687 0.2S class metering.

f) No annual re-calibration by users shall be required to maintain published accuracy.

g) Voltage and current for all phases shall be sampled simultaneously to assure high accuracy in conditions of low power factor or large waveform distortions (harmonics).

9. Waveform Capture

a) All Circuit Monitors shall include current and voltage waveform capture capability. Waveform capture shall be user selectable for sixteen (16) cycles to five hundred twelve (512) cycles of data. Or can be user specified up to thirty (30) seconds.

b) Waveform capture shall be initiated either from a Personal Computer Workstation (PCW) running the Power Monitoring and Control Systems software, or by the circuit monitor as a user defined response to an alarm condition.

c) Waveform capture manually triggered from the Power Monitoring and Control System software shall be captured at five hundred twelve (512) samples/cycle for one (1) cycle providing harmonic content up to the 255th harmonic for Ia, Ib, Ic, I4, Va, Vb, Vc, Vg.

d) Three types of waveform capture shall be available for response to an alarm condition:

1) Steady State shall be manually initiated and provide a resolution of five hundred twelve (512) samples/cycle.
2) Disturbance shall be initiated manually or by an alarm condition and allow the user to select a resolution of sixteen (16) to five hundred twelve (512) samples/cycle and a duration of nine hundred fifteen (915) to one (1) cycle.
3) Adaptive shall be initiated manually or by an alarm condition and allow the user to select a resolution of sixteen (16) to five hundred twelve (512) samples/cycle and a duration of one thousand three hundred twenty (1,320) to one (1) second.

e) The Circuit Monitor shall transmit the waveform samples over the network to the personal computer workstation for display, archival, and analysis.

f) Each voltage and current of all the phases shall be sampled concurrently so that proper phase relationships are maintained, so that harmonic flow analysis can be performed, and so that the effect of a disturbance can be observed on all phase voltages and currents.

g) Harmonic analysis performed on the captured waveforms shall resolve harmonics through the 255th using Power Monitoring and Control Software.

h) All waveforms must reflect actual circuit performance. Waveforms synthesized or composed over time shall not be acceptable.

10. Logging

a) Data logging may be accomplished either within the circuit monitor or at the PC Workstation, or both. Each circuit monitor shall be able to log data, alarms and events, and multiple waveforms. The monitors shall contain a minimum of 8MB of on-board nonvolatile memory, which can be field upgraded without requiring disassembly or removal the Circuit Monitor. On board data logs shall be communicated to the PC Workstation upon demand or at scheduled intervals. Logged information to be stored in each Circuit Monitor includes:

1) Up to fourteen (14) separate data logs shall be configurable by the user. Each log entry shall be date and time stamped. The type of data for the log shall be selected from a list of over one hundred fifty (150) monitored values. Each log entry shall be user configurable to consist of from one to over seventy five (75) values of instantaneous data. It shall be possible to set up each log to record data at independent user defined intervals. In addition, it shall be possible for a user to define an event or new min/max condition that will trigger log file entries.
2) Data logs can be configured by users to be Fill & Hold or Circular (FIFO).
3) A Min/Max log file shall include the time, date, and value for the minimum and maximum of each of the instantaneous metered values since last reset. As well as a Min/Max/Avg. log that records the minimum/maximum/average readings for pre-defined quantities at a user-specified interval.
4) An alarm and event log shall contain time, date, event information, and coincident information for each user defined alarm or event. This log shall have a capacity of up to one thousand (1,000) events.
5) Waveform logs shall store captured waveforms as defined by the user. Waveform log entries shall be scheduled at user defined interval, externally triggered, or forced in response to a user defined event. Waveform logs shall be either Fill & Hold or Circular (FIFO) as defined by the user.
6) The Power Monitoring and Control System software shall be available to enable the user to allocate onboard Circuit Monitor memory for each logging function.

11. Alarming

a) Alarm events shall be a combination of pre-configured from the factory events and user definable events Multiple levels of alarms can be configured for each metered parameter.
b) The following classes of events shall be available as alarm events:

1) Over/under current
2) Over/under voltage
3) Current imbalance
4) Phase loss, current
5) Phase loss, voltage
6) Wave Shape Alarm
7) Voltage imbalance
8) Over kVA
9) Over kW or kVAR into/out of load
10) Over/under frequency
11) Under power factor, true or displacement

12) Over THD
13) Over K-factor
14) Over demand, current or power
15) Reverse power
16) Phase reversal
17) Status Input change
18) End of incremental energy interval
19) End of demand interval
20) Over/under analog inputs
21) Current sag/swell
22) Voltage sag/swell
23) Transients (Where available)

c) For each over/under metered value alarm, the user shall be able to define a pick-up, drop-out, and delay.

d) The user will have the ability to alarm using a Waveshape Alarm feature based on user set thresholds by defining the following parameters:

1) Phase Voltage
2) Neutral Ground Voltage
3) Phase Current
4) Neutral Current

e) There shall be four alarm severity levels in order make it easier for the user to respond to the most important events first.

f) Indication of an alarm condition shall be given on the local display as well as reported to the Power Monitoring and Control System software.

g) The Circuit Monitor shall calculate key electrical parameters at 100ms intervals for the purpose of alarming and recording of data during an event. The recorded data shall be comprised of RMS readings for I, V, kW, kVAR, kVA, and True PF. 1-10 seconds of pre-event and up to five (5) minutes of post event data can be recorded.

12. Waveshape Alarm

a) The Circuit Monitor shall include waveshape alarm capability. This capability is characterized by the following features:

1) The Circuit Monitor shall be capable of continuously monitoring waveform anomalies in the following:

(a) Phase voltages
(b) Neutral to ground voltages
(c) Phase currents
(d) Neutral currents

b) Anomalous waveshape events less than 1/2 cycle in length shall be detected.
c) The user shall be able to set a threshold value and upper limit in the circuit monitor to determine if a waveshape event has occurred. The threshold and upper limit shall be user-defined values between zero (0) and one hundred (100). The threshold value is the limit at which a waveshape alarm will trigger. The upper limit defines the highest waveshape value that will trigger a waveshape alarm.
d) Upon detecting a disturbance, the Circuit Monitor shall be capable of:

1) Logging a waveform of the event all phase currents and voltages and/or a high-speed 100ms RMS event recording.
2) Recording the disturbance into an event log with a date and time stamp to the millisecond.
3) Causing an operator alarm at the PCW workstation.
4) Determining the source of the disturbance (upstream or downstream from the meter) and a statistical level of confidence (low, medium, high) of the accuracy of the source location.

13. Alarm Setpoint Learning (ASL)

a) Using SMS software (3.3.2 or greater), the user can enable the Series 4,000 Circuit Monitor to learn the characteristics of normal operation of metered values and select alarm setpoints based on this data.
b) The user is able to determine the quantities to be learned and the period of time for the learning process for standard-speed and high-speed analog alarms, disturbance alarms, and waveshape alarms.
c) The user can configure this feature using one of two (2) modes:

1) Fixed Learning: Initially configured user setpoints are used during the entire learning period.
2) Dynamic Learning: Initially configured user setpoints are temporarily replaced by learned setpoints at the interval specified by the user in SMS. The setpoints continue to be updated at the specified interval until the learning period expires.

d) The user can configure the duration of the learning period. If the learned setpoints do not change over a predefined period, the process can be stopped and the setpoints either installed or held for review.

14. Communications

a) The Circuit Monitor shall communicate via RS-232, RS-485, and Ethernet simultaneously.

b) The Circuit Monitor shall provide Modbus communications using Modbus TCP via an Ethernet network at 10/100Mbaud using UTP or Fiber connections. The Circuit Monitor shall provide the capability to communicate to thirty one (31) additional Modbus devices existing on RS-485 daisy chains and report data back to the PMCS application software or across the Ethernet network to other software applications.

c) The Circuit Monitor display shall provide an RS-232 communications port on board the metering module as well as an IR RS-232 communications port located on the display. The display port shall be completely accessible during normal operation and shall not require exposure of the operator to life-threatening voltage when in use. The operator shall be able to quickly connect a small Personal Computer (PC) to either the module port or the display port without use of tools or splices. Both the metering module port and the display port shall have all of the communication functionality of the standard hard-wired port. When a connection is made to either the metering module port or the display port, the Circuit Monitor shall continue simultaneous operation of all communication ports associated with the Circuit Monitor.

d) It shall be possible to field upgrade the firmware in the Circuit Monitor to enhance functionality. These firmware upgrades shall be done through either the display port or communication connection. No Circuit Monitor disassembly or changing of integrated circuit chips shall be required. It shall not be necessary to de-energize the circuit or the equipment to upgrade the firmware.

e) The circuit monitor shall allow communication to all ports simultaneously.

f) The circuit monitor shall have the option to serve data over the Ethernet network accessible through a standard web browser. Information shall be available from the circuit monitor and from Modbus slave devices connected downstream from the monitor. The monitor shall contain default pages from the factory and also have the ability for the user to create custom pages as needed.

g) The circuit monitor shall provide e-mail notification of any alarm condition that it detects.

h) Time synchronization to one (1) millisecond between monitors via GPS synchronization.

15. I/O Options

a) Circuit Monitor Input/Output Options: Input/Output options/modules shall be field replaceable. Circuit Monitors shall provide pre-configured I/O options and also provide I/O options to be configured as applicable to each installation as shown on the project drawings:

1) One solid state output suitable for KYZ pulse initiation; four solid state status inputs; three (10A) mechanical output relays

2) Four solid state status inputs; four analog inputs (4-20 mA)
3) Four inputs (32Vdc); 2 solid state outputs (60Vdc); 1 analog input (0-5Vdc); 1 analog output (4-20mA)
4) Eight solid state status inputs (120Vac)
5) Circuit Monitor shall provide configurable I/O options to include solid state input modules for 120Vac, 200Vac, and 32Vdc; solid state outputs modules for 120Vac, 240Vac, 60Vdc, 240Vdc; analog input modules for 0-5Vdc, 4-20mA; analog output module for 4-20mA.

16. Output Relay Control

a) Relay outputs shall operate either by user command sent over the communication link, or set to operate in response to user defined alarm event.
b) Output relays shall close in either a momentary or latched mode as defined by the user.
c) Each output relay used in a momentary contact mode shall have an independent timer that can be set by the user.
d) It shall be possible for individual relay outputs to be controlled by multiple alarms in a wired "OR" configuration.

17. Disturbance Detection

a) All Circuit Monitors noted on the project drawings shall include sag and swell detection capability. This capability is characterized by the following features:

1) The Circuit Monitor shall continuously monitor for disturbances in the currents and incoming voltage. There shall be zero (0) blind time; each cycle shall be individually monitored.
2) Disturbance events less than one half (1/2) cycle in length shall be detected.
3) The user shall be able to set a threshold and delay which shall be used by the circuit monitor to determine if an event has occurred. The threshold shall be user defined as either a fixed set point or relative set point. When using the relative set point, the Circuit Monitor will set the nominal current or voltage equal to its present average value. The Circuit Monitor will automatically adjust the nominal current and voltage values to avoid nuisance alarms caused by gradual daily variations of currents and voltages.

b) Upon detecting a disturbance, the Circuit Monitor shall be capable of :

1) Logging a waveform of the event all phase currents and voltages and/or a high-speed 100ms RMS event recording.

2) Operating any output relay on an optional I/O module.
3) Recording the disturbance into an event log with a date and time stamp to the millisecond.
4) Determining the direction of the cause of disturbance and categorize as "Upstream" from the meter or "Downstream" from the meter with an assigned confidence factor in the algorithm, then annunciate this determination through software.
5) Causing an operator alarm at the PCW workstation.

c) The user shall have the ability to display the voltage sag/swell events on ITIC or SEMI graphs to quantify the event with respect to accepted industry standards. If so desired the user shall also have the ability to view this information on custom web pages over the Internet when used with a communications card.

d) All data and waveform logs shall be communicated over the local area network or through the front panel communications port so that the user may view and analyze the data using the PMCS software and workstation.

e) The location of the source of the disturbance (upstream or downstream from the meter) may be provided for each event. A statistical level of confidence (low, medium, high) will be provided of the accuracy of the source's location.

18. Display

a) The Circuit Monitor display shall allow the user to select one (1) of six (6) languages to view on the screen:

1) English
2) French
3) Spanish.
4) Italian
5) Polish
6) German

b) The Circuit Monitor display shall also allow the user to select a date/time format and the ability to create additional screens for user-specified views and/or custom quantities without overwriting existing standard screens.

c) The Circuit Monitor display shall provide local access to the following metered quantities as well as the minimum and maximum value of each instantaneous quantity since last reset of min/max:

1) Current, per phase rms, 3-phase average and neutral (if applicable)
2) Voltage, phase-to-phase, phase-to-neutral, and 3-phase average (phase-to-phase and phase-to-neutral)
3) Real power, per phase and 3-phase total
4) Reactive power, per phase and 3-phase total

5) Apparent power, per phase and 3-phase total
6) Power factor, 3-phase total and per phase
7) Frequency
8) Demand current, per phase and three phase average
9) Demand real power, three phase total
10) Demand apparent power, three phase total
11) Accumulated Energy, (MWh and MVARh)
12) THD, current and voltage, per phase
13) K-factor, current, per phase

d) Reset of the following electrical parameters shall also be allowed from the Circuit Monitor display:

1) Peak demand current
2) Peak demand power (kW) and peak demand apparent power (kVA)
3) Energy (MWh) and reactive energy (MVARh)
4) Setup for system requirements shall be allowed from the Circuit Monitor display. Setup provisions shall include:
5) CT rating
6) PT rating
7) System type [three-phase, 3-wire] [three-phase, 4-wire]
8) Demand interval (5-60 min.)
9) Watt-hours per pulse

e) For ease in operator viewing, two displays are offered for local viewing of Circuit Monitor data. The liquid crystal display (LCD) shall include back lighting. The enhanced vacuum fluorescent display (VFD) shall be automatically activated by a proximity sensor as the operator approaches.

19. Programming

a) Where indicated on the drawings, the Circuit Monitors shall be designed to run customized programs to greatly expand the Circuit Monitor's functionality for the particular installation.
b) These programs shall be written in a circuit monitor programming language similar to a compiled "BASIC" language. It shall include the following capabilities:

1) Scheduled tasks
2) Event Tasks
3) Math functions including: add, subtract, multiple, divide, sine, cosine, square root, etc.
4) Logical functions including: AND, OR, XOR, NOT, shift, etc.
5) Loop commands
6) Compare statements

7) Counters and timers

c) The circuit monitor manufacturer shall offer custom programming services.

d) Changing programs shall not require any physical modifications to the Circuit Monitor, such as changing computer chips or cards. All changes shall be done via either of the communications ports.

e) Examples of custom programs would include:

1) Metering of specialized utility rate structures, including real time pricing and curtailable rates
2) Data reduction using smart data logging
3) Automatic monthly logging/reset of kWh and Peak Demand
4) Statistical profile analysis of metered quantities
5) ITIC/SEMI power quality analysis
6) Calculations for IEEE-519 verification
7) Metering of combined utilities: gas, water, steam, electric
8) Non-critical control schemes, such as load control or power factor correction, based on multiple conditions e.g. time of day and input status

20. Current/Voltage Inputs

a) The Circuit Monitors shall accept metering inputs of up to 600Vac direct connection or from industry standard instrument transformers (120 VAC secondary PTs and 5 A secondary CTs). Connection to 480Y/277 VAC circuits shall be possible without use of PTs.

b) PT primaries through 1.2 MV shall be supported

c) CT primaries through 32 kA shall be supported

d) The Circuit Monitor shall be accurate to 0.04% of reading plus/minus 0.025% of full scale for voltage and current metering and 0.08% of reading plus 0.025% for power.

e) The Circuit Monitor's energy readings shall meet the revenue accuracy requirements of ANSI C12.20 0.2 class metering.

f) No annual re-calibration by users shall be required to maintain published accuracy.

21. Feature Additions

a) It shall be possible to field upgrade the firmware in the Circuit Monitor to enhance functionality. These firmware upgrades shall be done through the communication connection and shall allow upgrades of individual meters or groups. No disassembly or changing of integrated circuit chips shall be required and it will not be necessary to de-energize the circuit or the equipment to perform the upgrade.

b) The Circuit Monitors shall be rated for an operating temperature range of -25^{0}C to 70^{0}C and have an over current withstand rating of 500 amps for one (1) second.
c) All setup parameters required by the Circuit Monitors shall be stored in nonvolatile memory and retained in the event of a control power interruption.
d) The Circuit Monitor shall be capable of being applied without modification at nominal frequencies of 50, 60, or 400 Hz.

e) The Circuit Monitor (CM4250) shall include anti-aliasing filters on both voltage and current metering inputs. These anti-aliasing filters are capable of having the corner frequency adjusted between 50Ha, 60Hz, or "off" modes.
f) The Circuit Monitor (CM4250) shall have a Cat IV overvoltage withstand rating on the voltage metering inputs.

22. The Circuit Monitor shall operate properly over a wide range of control power including 100-305 VAC or 100-300 VDC. Connections to 18-60 VDC shall also be available.
23. Ride through capability shall be available for backup control power for up to two (2) seconds, the rms values, as selected by the user.
24. The Circuit Monitor shall provide a hardware security switch to protect all revenue related metering configuration from unauthorized/accidental changes. The Circuit Monitor shall support the use of a wire seal to further deter inadvertent configuration changes and provide visual tamper indication.
25. The Circuit Monitor shall be a PowerLogic ION 7400 or PowerLogic Ion 9000T with small screen display as manufactured by Square D Company. Refer to Medium Voltage Switchgear specifications for meter locations.

B. Power Meters: For meters on 480V ATS's and meters not specified in MV Switchgear or LV Secondary Substation specifications, provide Square D PM5340 meters. Meters shall have Ethernet communication port.

1. Measured values

a. The Power Meter shall provide the following, true RMS metered quantities:

1) Real-Time Readings
2) Current (Per-Phase, N (calculated), 3-Phase Avg)
3) Voltage (L–L Per-Phase, L-L 3-Phase Avg, L–N Per-Phase, L-N 3-Phase Avg.)
4) Real Power (Per-Phase, 3-Phase Total)*
5) Reactive Power (Per-Phase, 3-Phase Total)*
6) Apparent Power (Per-Phase, 3-Phase Total)
7) Power Factor Signed (3-Phase Total)

8) Frequency
9) THD (Per-Phase, Current and Voltage)

b. Energy Readings

1) Accumulated Energy (Real kWh*, Reactive kVarh*, Apparent KVAh) (Absolute)

c. Demand Readings

1) Demand Current Calculations(Per-Phase):

a) Present
b) Peak

2) Demand Real Power Calculations(3-Phase Total):

a) Present
b) Peak

3) Demand Reactive Power Calculations(3-Phase Total):

a) Present
b) Peak

4) Demand Apparent Power Calculations(3-Phase Total):

a) Present
b) Peak

d. Power Analysis Values

1) THD - Voltage (Per-Phase, Line to Line, Line to Neutral
2) THD - Current (Per-Phase, Neutral)
3) Signed Power Factor (3-Phase)

e. Usage Time: The Power Meter should display the time that the device has been in service, displaying hours and minutes.

* kW, kVAR, kWh, and kVARh are signed net consumption values. The PM750 keeps a single registers with the net consumption values per each type of Energy and Power.

2. Demand: All power demand calculations shall use any one (1) of the following calculation methods, selectable by the user:

a. Block Interval Demand. The three following demand calculation modes shall be possible under Block Interval Demand: Sliding Block, Fixed Block, and Rolling Block.
b. Synchronized Demand
c. Thermal Demand

3. Sampling

a. The current and voltage signals shall be digitally sampled at a rate high enough to provide true rms accuracy to the 15th harmonic.
b. The Power Meter shall provide continuous sampling at a minimum of up to thirty two (32) samples/cycle, simultaneously on all voltage and current channels of the meter.

4. Minimum and Maximum Values

a. The Power Meter shall provide minimum and maximum values for the following parameters:

1) Voltage L-L
2) Voltage L-N
3) Current
4) Power Factor
5) Real Power Total
6) Reactive Power Total
7) Apparent Power Total
8) THD Voltage L-L
9) THD Voltage L-N
10) THD Current
11) Frequency

b. For each min/max value listed above, the Power Meter shall record the following attributes:

1) Min/Max. Value
2) Phase of recorded Min/Max (for multi-phase quantities)

c. Minimum and maximum values shall be available via communications and display.

5. Current Inputs

a. The Power Meter shall accept current inputs from standard instrument current transformers with 5 amp secondary output and shall have a metering range of 5mA-6 amps with the following withstand currents: 10 amp continuous, 50 amp 10 sec per hour, 120 amp 1 sec per hour.

b. Current transformer primaries adjustable from 5 - 32,767 A shall be supported.

6. Voltage Inputs

a. The circuit monitor shall allow connection to circuits up to 480 volts AC without the use of potential transformers. The Power Meter shall also accept voltage inputs from standard instrument potential transformers. The Power Meter shall support PT primaries through 1.6 MV.
b. The nominal full scale input of the Power Meter shall be 277 Volts AC L-N, 480 Volts AC L-L. The meter shall accept a metering over-range of 20%. The input impedance shall be greater than 2 Mohm (L-L) or 1 Mohm(L-N).

7. Accuracy

a. The Power Meter shall comply with IEC62053-22 Class 0.5S for Real Energy and IEC62053-23 Class 2 for Reactive Energy
b. Voltage shall be accurate to 03% from 50 to 227 V. Current shall be accurate to 0.4% from 1 to 6A. Power Factor shall be accurate from 1 to 6A. Power shall be accurate to 0.5%. Frequency metering shall be accurate to + 0.2 % from 45-65 Hz.
c. No annual calibration shall be required to maintain this accuracy.

8. Input/Output

a. The Power Meter shall include on-board two (2) Digital Inputs and One Digital Pulse Output. The Power Meter shall be capable of operating a solid state KY output relay to provide output pulses for a user definable increment of reported real energy. The standard KY output shall operate from 8–36 V DC max range, 24 V DC nominal. @ 25°C, 3.0 kV rms isolation, 28 Ω on-resistance @ 100 mA. It shall allow for the following operation modes:

1) External-This is the default setting. The output can be controlled by a command sent over the communications link.
2) Alarm-The output is controlled by the power meter in response to a Setpoint controlled alarm condition. When the alarm is active, the output will be ON. Multiple alarms can be associated with the same output simultaneously.
3) kWh Pulse-In this mode, the meter generates a fixed-duration pulse output that can be associated with the kWh consumption.

b. The Power Meter shall be capable of operating the two (2) Digital Inputs to provide all the following modes:

1) Normal-Use the normal mode for simple ON/OFF digital inputs.
2) Demand Interval Synch Pulse-Use this mode to configure a digital input to accept a demand synch pulse from a utility demand meter.
3) Digital Alarm-Use this mode to associate the input operation with any of the alarms. These alarms shall have a fixed pickup and dropout magnitude:
4) The two digital inputs shall operate from 12-36 V DC, 24 VDC nominal, impedance 12k Ohm, maximum frequency 25 Hz, response time 10 msec, and isolation 2.5kV rms

9. Upgrades

a. It shall be possible to field upgrade the firmware in the Power Meter to enhance functionality. These firmware upgrades shall be done through the communication connection and shall allow upgrades of individual meters or groups. No disassembly, changing of integrated circuit chips or kits shall be required and it will not be necessary to de-energize the circuit or the equipment to perform the upgrade.

10. Control Power

a. The Power Meter shall operate properly over a wide range of control power including 100-415 VAC, +/-10%, 5VA; 50 to 60Hz. Or 125-250 VDC, +/-20%, 3W.

11. Communications

a. The Power Meter shall communicate via RS-485 Modbus protocol with a 2-wire connection at speeds up to 19.2 kBaud.

12. Alarms: The Power Meter shall detect 15 predetermined alarms. All alarms shall be configured with the following values when using the display:

a. Enable-disable (default) or enable.
b. Pickup Magnitude
c. Pickup Time Delay
d. Dropout Magnitude
e. Dropout Time Delay
f. Values that can also be configured over communications are:
g. Alarm Type
h. Test Register
i. Alarm Label

13. Display

a. The Power Meter display shall be back lit LCD for easy viewing, display shall also be anti-glare and scratch resistant.
b. The Display shall be capable of allowing the user to view four values on one screen at the same time. A summary screen shall also be available to allow the user to view a snapshot of the system.
c. The Power Meter display shall provide local access to the following metered quantities:

    1) All quantities in Section B
    2) Minimum and Maximum readings in Section E
    3) Any of the Active Alarms from Section P
    4) I/O Status
d. Reset of the following electrical parameters shall also be allowed from the Power Meter display:

    1) Peak demand current
    2) Peak demand real power (kW) and peak reactive demand (kVAR).
    3) Energy (MWh) and reactive energy (MVARh)
e. Setup for system requirements shall be allowed from the Power Meter display. Setup provisions shall include:

    1) CT rating
    2) PT rating (Single Phase, 2-Wire)
    3) System type [three-phase, 3-wire] [three-phase, 4-wire]
    4) Watt-hours per pulse
    5) Communication parameters such as address and baud rate
    6) Alarms
    7) Digital I/O
    8) Demand calculation mode settings
    9) Bar graphs
    10) And Passwords for Setup and Reset]

2.5 ELECTRICAL METERING CABINET

A. The metering cabinet shall be appropriate for its environment but at a minimum UL type 1 listed steel enclosure with factory supplied knock-outs, or as specified on the drawings. The cabinet shall be approved for Type 1 and Type 3R applications. The enclosure shall have one set of incoming terminals for connecting the voltage metering leads.

B. Control power and voltage sensing power shall be separated for distribution to each meter from these main set incoming terminals.

C. External control power transformers shall not be needed for any power systems up to and including 480V.

D. Metering cabinet shall have fuse blocks for incoming voltage leads.

E. The enclosure shall have shorting terminal blocks for connecting the current transformer leads from the field to the meters. A factory wiring harness shall be provided to connect the CT circuit from shorting block to the meter.

F. The metering cabinet shall have terminal blocks for incoming and outgoing communications circuit connections.

2.6 LAN CABLES

A. Comply with Division 27 Section "Communications Horizontal Cabling."

B. RS-485 Cable:

1. Plenum-Type, RS-485 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, shielded, and fluorinated-ethylene-propylene jacket, and NFPA 70, Type CMP. Belden #8723 or approved equal.

C. Unshielded Twisted Pair Cables: Category 6 as specified for horizontal cable for data service in Division 27 Section "Communications Horizontal Cabling."

2.7 LOW-VOLTAGE WIRING

A. Comply with Division 26 Section "Control-Voltage Electrical Power Cables."

B. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.

1. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
2. Ordinary Switching Circuits: Three conductors unless otherwise indicated.
3. Switching Circuits with Pilot Lights or Locator Feature: Five conductors unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION AND SOFTWARE INTEGRATION

A. All new electric meters added under this project including, but not limited to, the meters installed in Howard Hall, Bressler Research Building, the Peaking Plant, the North Switching Station, HSF1 and MSTF shall receive startup, programming, commissioning, and integration with the existing campus Power Monitoring Expert (PME) system.
   1. For the Peaking Plant meters, the electric meter shall also be programmed to include the totalized gas flow meter pulses and monitor the status from the gas booster pump.

B. Existing Peaking Plant Generator Meters: Under this project, the contractor shall include programming and integration of the two (2) existing ION 750 meters that are installed on the two existing generators at the peaking plant. The contractor shall integrate the meter into the existing Power Monitoring Expert (PME) system. This work shall also include the totalizez gas flow meter pulses from the generator fuel flow meters, the BGE gas meter pulses, and monitoring of the Gas Booster Pump common alarms.

3.3 INTEGRATION WITH BAS SYSTEM

A. Contractor shall provide communication with BAS system to provide information into the BAS system for the items listed below. The contractor shall include costs for inserting 10 points into the BAS sytem. The BAS system and metering system are on the same network.
   1. Distribution System on Generator (Howard Hall/BRB Generators and Peaking Plant Generators are running and supplying power to the North Switching Station)
   2. Common Alarms

3.4 CABLING

A. Comply with NECA 1.

B. Install cables and wiring according to requirements in Division 27 Section "Communications Horizontal Cabling."

C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

D. Install LAN cables using techniques, practices, and methods that are consistent with specified category rating of components and that ensure specified category performance of completed and linked signal paths, end to end.

E. Install cables without damaging conductors, shield, or jacket.

3.5 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

B. Label each power monitoring and control module with a unique designation.

3.6 GROUNDING

A. Comply with IEEE 1100, "Recommended Practice for Powering and Grounding Electronic Equipment."

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Electrical Tests: Use caution when testing devices containing solid-state components.
2. Continuity tests of circuits.
3. Operational Tests: Set and operate controls at workstation and at monitored and controlled devices to demonstrate their functions and capabilities. Use a methodical sequence that cues and reproduces actual operating functions as recommended by manufacturer. Submit sequences for approval. Note response to each test command and operation. Note time intervals between initiation of alarm conditions and registration of alarms at central-processing workstation.

    a. Coordinate testing required by this Section with that required by Sections specifying equipment being monitored and controlled.
    b. Test LANs according to requirements in Division 27 Section "Communications Horizontal Cabling."
    c. System components with battery backup shall be operated on battery power for a period of not less than 10% of calculated battery operating time.
    d. Verify accuracy of graphic screens and icons.
    e. Metering Test: Load feeders, measure loads on feeder conductor with an rms reading clamp-on ammeter, and simultaneously read indicated current on the same phase at central-processing workstation. Record and compare values measured at the two locations. Resolve discrepancies greater than 5 percent and record resolution method and results.
    f. Record metered values, control settings, operations, cues, time intervals, and functional observations and submit test reports printed by workstation printer.

C. Power monitoring and control equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

F. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

G. Reports: Submit written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

H. Remove and replace malfunctioning devices and circuits and retest as specified above and note corrective action in report.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train owner's maintenance personnel to adjust, operate, and maintain systems. See Division 01 Section "Demonstration and Training."

1. Train owner's management and maintenance personnel in interpreting and using monitoring displays and in configuring and using software and reports. Include troubleshooting, servicing, adjusting, and maintaining equipment. Provide a minimum of two (2) hours training.
2. Training Aid: Use approved final versions of software and maintenance manuals as training aids.

3.9 ON-SITE ASSISTANCE

A. Occupancy Adjustments: When requested within twenty four (24) months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 260913

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

A. This Section includes the following lighting control devices:
   1. Outdoor and indoor photoelectric switches.
   2. Indoor occupancy sensors.
   3. Lighting contactors.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

1.4 SUBMITTALS

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

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

   1. Interconnection diagrams showing field-installed wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

1.7 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the manufacturers specified:

1. Area Lighting Research, Inc.; Tyco Electronics.
2. Intermatic, Inc.
3. Paragon Electric Co.; Invensys Climate Controls.
4. TORK.
5. Watt Stopper (The).

B. Description: Solid state, with DPSTdry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
2. Time Delay: 15-second minimum, to prevent false operation.
3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.2 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the manufacturers specified:

1. Hubbell Lighting.
2. Leviton Mfg. Company Inc.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Novitas, Inc.
5. RAB Lighting, Inc.
6. Sensor Switch, Inc.
7. TORK.
8. Watt Stopper (The).

B. General Description: Wall- or ceiling-mounting mounted, solid-state units with a separate relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of one (1) minute to fifteen (15) minutes.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, and Class 2 power source as defined by NFPA 70.
4. Mounting:

    a. Sensor: Suitable for mounting in any position on a standard outlet box.
    b. Relay: Externally mounted through a one half (1/2) inch knockout in a standard electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from two (2) fc to two hundred (200) fc; keep lighting off when selected lighting level is present.

C. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of six (6) inch minimum movement of any portion of a human body that presents a target of not less than thirty six (36) sq. in., and detect a person of average size and weight moving not less than twelve (12) inches in either a horizontal or a vertical manner at an approximate speed of twelve (12) inches.

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of one thousand (1,000) sq. ft. when mounted on a ninety six (96) inch high ceiling.

2.3 LIGHTING CONTACTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the manufacturers specified:

1. ASCO Power Technologies, LP; a division of Emerson Electric Co.
2. Eaton Electrical Inc.; Cutler-Hammer Products.
3. Hubbell Lighting.
4. MicroLite Lighting Control Systems.
5. Square D; Schneider Electric.
6. TORK.
7. Touch-Plate, Inc.
8. Watt Stopper (The).

B. Description: Electrically operated and mechanically held, combination type with fusible switch complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including LED driver for light fixtures.
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.

1. Monitoring: On-off status.
2. Control: On-off operation.

2.4 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 90% coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device, and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within twelve (12) months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 260923

SECTION 261116 - SECONDARY UNIT SUBSTATIONS

PART 1 - GENERAL

1.1 RELATED DOCOMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

A. This Section includes indoor and outdoor secondary unit substations, each consisting of the following:

1. Primary incoming section.
2. Transformer.
3. Secondary distribution section.

1.3 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.4 SUBMITTALS

A. Compliance Statement as described under the quality assurance section of this specification.

B. Product Data: Include rated capacities, furnished specialties, and accessories.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Dimensioned plans and elevations showing major components and features including working clearances, conduit entry points, and base mounting points.
3. One-line diagram.
4. List of materials.
5. Nameplate legends.
6. Size and number of bus bars and current rating for each bus, including mains and branches of phase, neutral, and ground buses.

7. Short-time and short-circuit current ratings of secondary unit substations and components.
8. Ratings of individual protective devices.
9. Transformer section submittals (where transformer is specified) including:
    a. Dimensioned plan and elevations with tap, control power transformer, fan and temperature monitor locations, and phase, neutral and ground connection locations.
    b. Enclosure details, including removable panel descriptions, louver locations, control wiring routing, sheet metal gauge, and painting details.
    c. Terminal locations and details for phase, neutral and ground connections.
    d. Coil conductor materials and construction.
    e. Insulation materials.
    f. Test data sheets for similar transformers with test data on load losses, no-load losses and sound level.
    g. Temperature control system description, including details on the control power transformer, fans, temperature monitor, alarms and hinged panel for the monitor.
    h. Schematic and connection diagrams for the temperature control system.
    i. Full size copy of the nameplate.
    j. Coil-to-bus/line connection materials, support and details.
    k. Bus bar and line termination connection and support details.
    l. ANSI Damage curve for secondary unit substation transformers.
    m. Detailed location, mounting and wiring of the lightning arrestors.
    n. Primary Fuses: Submit recommendations and size calculations.
10. Secondary voltage distribution section submittals containing:
    a. Dimensioned plan and elevations with circuit breaker, current sensor and metering device locations, and phase, neutral and ground bus terminal locations.
    b. One line diagram with bus, circuit breaker, trip unit, metering device and fuse quantities and ratings, and interlock provisions.
    c. Compartment details including front door and rear panel descriptions, sheet metal gauge, painting details, mimic bus details, and breaker lifting device description.
    d. Terminal locations and details for phase, neutral and ground connections.
    e. Phase-to-phase clearances and phase-to-ground clearances.
    f. Bus bar connection and support details and bus materials.
    g. Insulator and barrier details and materials.
    h. Circuit breaker, trip unit, and current sensor descriptions.
    i. Trip unit time-current characteristic curves.
    j. Detailed circuit breaker controls details, schematic and connection diagrams, and sequences of operation including terminal point numbers and locations
    k. Secondary metering description, including details on the current transformers, potential transformers, ammeters, voltmeters, and meter switches.

l. Schematic and connection diagrams for the secondary metering systems.
m. Schematic and connection diagrams for the PLC system including terminal point numbers and locations
n. DC Connection schematics including terminal point numbers and locations
o. Nameplate engraving.
p. Time-current curves, including selectable ranges for each type of overcurrent protective device.
q. Mimic-bus diagram.

D. 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. Dimensioned concrete base, outline of secondary unit substation, conduit entries, and ground rod locations.
2. Location of structural supports for structure-supported raceways and busways.
3. Location of lighting fixtures, sprinkler piping and heads, ducts, and diffusers.

E. Product Certificates: For secondary unit substations, signed by product manufacturer.

F. Qualification Data: For independent testing agency.

G. Material Test Reports: For secondary unit substations.

H. Factory test reports.

I. Field quality-control test reports.

J. Operation and Maintenance Data: For secondary unit substations and accessories to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Compliance Statement: The equipment manufacturer shall include a Compliance Statement, at the time of Bid, listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.

B. Independent Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain secondary unit substation through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of secondary unit substations and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

E. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with IEEE C2.

G. Comply with IEEE C37.121.

H. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.

B. Coordinate delivery of secondary unit substations to allow movement into designated space.

C. Store secondary unit substation components protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

D. Handle secondary unit substation components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.7 PROJECT CONDITIONS

A. Field Measurements: Indicate measurements on Shop Drawings.

B. Interruption of Existing electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify UM no fewer than 10 days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without UM's written permission.
3. Outages to existing loads shall occur during off hours.

    a. If contractor elects to do outages or switchovers during normal hours then contractor shall submit a plan to be approved by the owner and provide temporary power at no additional cost.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear, and adjacent surfaces and other items. The Equipment Manufacturer shall fabricate the equipment to within indicated maximum dimensions with clearances to accommodate access for maintenance and operation.

1.8 COORDINATION

A. Coordinate layout and installation of secondary unit substations with other construction that penetrates floors and ceilings, or is supported by them, including light fixtures, HVAC equipment, and fire-suppression-system components.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Spare fuses: 10% of total for project; each type and rating of fuse and fusible device used, except for medium-voltage fuses. Include spares for the following:

    a. Primary disconnect fuses.
    b. Potential transformer fuses.
    c. Control power fuses.
    d. Fuses and fusible devices for fused circuit breakers.
    e. Fuses for secondary fusible devices.

2. Spare Indicating Lights: Six of each type installed.
3. Touchup Paint: One half-pint container of paint matching enclosure's exterior finish.
4. Primary Switch Contact Lubricant: One container.

5. One set of spare mounting gaskets for bushings, handholes, and the gasket between relief cover and flange of pressure relief device

1.10 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
   1. Eaton
   2. Square D; Schneider Electric.

2.2 MANUFACTURED UNITS

A. Indoor Unit Arrangement: As shown on drawings.

B. Enclosure Finish: Factory-applied finish in manufacturer's standard color, including under surfaces treated with corrosion-resistant undercoating.

2.3 INCOMING SECTION

1. Primary Incoming Section. As indicated on the drawings provide one of the following: Terminal assembly with adequate space for incoming cable terminations and surge arresters, complying with NEMA SG 4 and meeting thermal, mechanical, and dielectric requirements specified for the transformer section.

2. Enclosed, air-interrupter, dual primary switch.
   a. Three pole, single throw, dead front, metal enclosed, with manual stored energy operator, frame complying with IEEE C37.20.3.
   b. Key interlocking system to prevent fuse access door from being opened unless switch is open
   c. Allow non-interlock operation of dual primary switches.
   d. Phase Barriers: Located between blades and fuses of each phase, designed for easy removal, allows visual inspection of switch components when barrier is in place.
   e. IR Port: 3 inches.

f. Window: Permits viewing switch-blade positions when door is closed.
g. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.
h. Continuous-Current Rating: 600 A.
   1) Short-Circuit Rating:
   2) Short-time momentary asymmetrical fault rating of 40 kA.
   3) 2-second symmetrical rating of 25-kA RMS.
   4) Fault close asymmetrical rating of 40 kA.
i. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading. Comply with the following:
   1) Current-limiting type, rated for not less than 50-kA RMS symmetrical current-interrupting capacity.
   2) Indicator integral with each fuse to show when it has blown.
   3) Spares: Include three fuses in use and three spare fuses in storage clips in each switch.

B. Surge Arresters: Comply with IEEE C62.11, Distribution class; metal-oxide-varistor type, with ratings as indicated, connected in each phase of incoming circuit and ahead of any disconnecting device. Comply with IEEE.

2.4 DRY-TYPE TRANSFORMER SECTION

A. Description: As indicated on the drawings provide:

IEEE C57.12.01,IEEE C57.12.51, NEMA ST 20, and dry-type, 2-winding, secondary unit substation transformer.

B. Enclosure: Indoor, ventilated, vacuum-pressure impregnated type, with insulation system rated at 185^0C with an 80^0C average winding temperature rise above a maximum ambient temperature of 40^0 C.

C. Cooling System: Class AA/FA, air cooled with forced-air rating complying with IEEE C57.12.01.
   1. Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm silencing relay.
   2. The temperature controller shall be mounted flush on the front of the transformer, 54 inches above finished floor.
   3. The temperature monitor shall be mounted on a hinged front plate of a flush mounted box. The electrical connection shall be accessible and the monitor shall be removable without de-energizing the transformer.
   4. The wiring for the temperature monitor shall be routed and supported independently of the transformer enclosure so that the enclosure panels can be

removed without affecting the wiring. All wiring shall comply with the requirements of the Control Wiring section of this specification.

5. The temperature monitor shall include an LED or LCD display to allow reading of the hot spot temperature in each phase, and the highest temperature seen on each phase since the last reset. Additional features as listed below:
6. A reset button shall be provided to reset the maximum readings.
7. Indication Lights:
8. Green – Power On
9. Amber – Fan On
10. Red – High Temperature
11. Alarm Silence Pushbutton
12. Auto/Manual Fan Control Switch
13. System Test Switch

D. Insulation Materials: IEEE C57.12.01, rated 220^0C.

E. Insulation Temperature Rise: 80^0C, maximum rise above 40^0C.

F. Basic Impulse Level: 95 kV.

G. Full-Capacity Voltage Taps: 4 nominal 2.5% taps, 2 above and two (2) below rated primary voltage.

H. Sound level may not exceed 64dBA level, without fans operating.

I. Impedance: 5.75 percent.

J. Transient Resistant Design: For transformers switched by vacuum circuit breakers and/or not closed coupled to a fused switch, transformers shall be provided with an RC Snubber to resist transients induced by the vacuum circuit breaker switching.

K. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm. Provide Square D Model 98 transformer temperature monitor for remote recording of transformer winding temperatures.

L. Core and Coil Assemblies: Transformer coils shall be copper continuously wound on a non-aging, cold-rolled, grain-oriented, high permeability silicon metal core of electrical grade steel with insulated laminations. Aluminum windings are not acceptable.

M. Core and coil assembly shall be mounted on a structural steel base, which shall be isolated from the rest of the structure by vibration pads.

N. The electrical insulation system shall utilize Class H material in a fully rated 220 degree C system. Transformer design temperature rise shall be based on a 30 degrees C average ambient over a 24-hour period with a maximum of 40 degrees C. Solid insulation in the transformer shall consist of inorganic materials such as porcelain, glass fiber, electrical grade glass polyester or Nomex. All insulating materials must be rated for continuous 220

degree C duty. The insulation between the high and low voltage coils shall be more than sufficient for the voltage stress without the need of a varnish.

O. High-voltage and low-voltage windings shall be copper. The high voltage winding shall be wound over the low voltage winding with sufficient mechanical bracing to prevent movement during fault conditions and sufficient solid insulation to isolate the high voltage winding dielectric potential from the low voltage windings.

P. Sound level may not exceed sound levels listed in NEMA TR 1, without fans operating.

2.5 SECONDARY DISTRIBUTION SECTION

A. North Switching Station Secondary Distribution: Low-voltage switchboard as specified in Division 26 Section "Switchboards."

B. For Howard Hall, Bressler Research Buidling, and HSF1 Generator Switchgear, the secondary distribution section shall be drawout, low-voltage switchgear, complying with IEEE C37.20.1 and UL 1558.
   1. Section barriers between all circuit-breaker compartments shall be extended to rear of section.

C. Switchgear Structure:
   1. Match and align the front and back of the switchgear.
   2. Isolate line bus from load bus at each main and tie circuit breaker with bus isolation barriers.
   3. Allow the following circuit-breaker functions to be performed when the compartment door is closed:

      a. Operate manual charging system.
      b. Open and close the circuit breaker.
      c. Examine and adjust the trip unit.
      d. Read the breaker nameplate.

   4. Locate instrumentation transformers within the breaker cell, and make front accessible and removable.
   5. The sections shall be constructed of steel frames and heavy gauge steel panels sized to maintain required alignments and clearances at all times. The sections shall also be sufficiently rigid to restrict deformation from external forces and weights that may be applied during maintenance activities.
   6. The sections shall be capable of withstanding the lifting, skidding, jacking and/or rolling (in any direction) actions needed to install the equipment. Factory installed lifting eyes shall be provided on each section.
   7. The sections shall have provisions for anchoring to channel embeds in the housekeeping pad.

8. Section barriers between all circuit-breaker compartments shall be extended to rear of section.
9. Bus isolation barriers shall be arranged to isolate line bus from load bus at each main and tie circuit breaker.
10. Circuit-breaker compartments shall be equipped to house drawout-type circuit breakers and shall be fitted with hinged outer doors.

D. Switchgear Bus:
1. Use bus bars to connect compartments and vertical sections. Cable connections are not permitted.
2. Main Phase Bus: Uniform capacity the entire length of section.
3. Vertical Section Bus Size: Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers.
4. Phase-Bus Material: Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
5. Use copper for connecting circuit-breaker line to copper bus.
6. Contact Surfaces of Buses: Silver plated.
7. Feeder Circuit-Breaker Load Terminals: Insulated silver-plated copper bus extensions equipped with bolted connectors for outgoing circuit conductors. Provide cable lugs sized as indicated on the drawings.
8. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size 1/4-by-2 inches (6 by 50 mm).
9. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
10. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, spray-applied, flame-retardant insulation.

    a. Sprayed Insulation Thickness: 3 mils (0.08 mm), minimum.
    b. Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

11. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents, 65kA.
12. The vertical bus shall be held rigid in a support structure of non-hygroscopic and flame retardant molded glass reinforced polyester.
13. Vertical and horizontal busbars shall be isolated from the cable compartment by steel barriers. No live busbars shall be accessible from the rear cable compartments except the circuit breaker load side terminations.
14. Cable feeder compartments shall have sufficient space for all cables entering from above and shall be easily accessible from the rear. Cable tie points shall be provided on the sides of such sections. No cable tie bars shall block access to the rear of the switchgear.

E. Special Provisions to Accommodate Switchgear Maintenance:

1. Barriers covering the bus sub-assembly in each section of gear shall be designed for ease of removal to accommodate maintenance.
2. Where carriage bolt assemblies are installed at bus connections, the bolts shall face the rear of the switchgear to facilitate access for maintenance.
3. The switchgear shall be arranged to allow thermal and ultrasonic scans with the bus energized and under load.

    a. Provide two (2) combined visual, Ultraviolet (UV), and Infrared (IR), rectangular viewing windows in the rear cover of each switchgear section. Center each window at 1/3 points along the height of the section and centered horizontally on the section so that all cable terminations can be scanned through the windows.
    b. Provide one (1) round ultrasonic scan window in the front door of each breaker compartment. Locate the window so that a scan can be made of the arc chutes and contacts of the breaker.

4. Provide design details to the Government's Representative prior to manufacturer to confirm compliance with the above provisions.

F. Circuit Breaker Compartment:
1. Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in "connected," "test," and "disconnected" positions. Include the following features:

    a. Interlocks: Prevent movement of circuit breaker to or from "connected" position when it is closed, and prevent closure of circuit breaker unless it is in "connected," "test," or "disconnected" position.
    b. Circuit-Breaker Positioning: Permit the racking of an open circuit breaker to or from "connected," "test," and "disconnected" positions only when the compartment door is closed unless live parts are covered by a full dead-front shield. Permit the manual withdrawal of an open circuit breaker to a position for removal from the structure. When the compartment door is open, status for connection devices for different positions includes the following:

        1) Test Position: Primary disconnects disengaged, and secondary disconnect devices and ground contact engaged.
        2) Disconnected Position: Primary and secondary devices and ground contact disengaged.

2. Primary Disconnect: Mount on the stationary part of the compartment. The disconnect shall consist of a set of contacts extending to the rear through an insulating support barrier, and of corresponding moving finger contacts on the power circuit-breaker studs, which engage in only the "connected" position. The assembly shall provide multiple silver-to-silver full floating, spring-loaded, high-pressure-point contacts with uniform pressure on each finger. Load studs shall

connect to bus extensions that terminate in solderless terminals in the rear cable compartment.

3. Secondary Disconnect: Floating terminals mounted on the stationary part of the compartment that engage mating contacts at the front of the breaker. Disconnecting devices shall be gold plated, and engagement shall be maintained in the "connected" and "test" positions.
4. Each compartment shall be dead-front. Shutters shall close automatically as a breaker is racked out of the “connected” position. Control contacts shall be “made” when the breaker is in the “test” or “connected” position.
5. A guide rail system shall be used to ensure accurate alignment of the breaker primary and secondary disconnects during drawout operation.
6. Positive mechanical interlocks shall prevent the circuit breaker from being racked in or out unless the circuit breaker is open, and shall prevent the circuit breaker from being closed while it is being racked in or out. The circuit breaker shall not be permitted to close except in the “connected” and “test” positions.
7. Each circuit breaker cubicle shall contain a positive rejection mechanism so that only the circuit breaker frame for which the cubicle was designed can be inserted.
8. Anti-pumping mechanism shall be provided.
9. Compartment doors shall have padlocking hasps.
10. Circuit breakers shall be capable of being padlocked in the drawn-out position.
11. Main, Tie, and Feeder Circuit Breaker Compartments: Shutters shall be supplied to cover circuit breaker primary line and load disconnects when the circuit breaker carriage is removed from its compartment.

G. Circuit Breakers:
1. Circuit breakers shall be individually mounted, drawout, 600 volt (nominal) power circuit breakers in compliance with ANSI C37.13, C37.16, C37.17, C37.50, NRTL-listed and labeled to UL-1066.
2. Ratings: For continuous, interrupting, and short-time current ratings for each circuit breaker as indicated on the drawings; voltage and frequency ratings same as switchgear.
3. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:

    a. Normal Closing Speed: Independent of both control and operator.
    b. Slow Closing Speed: Optional with operator for inspection and adjustment.
    c. Stored-Energy Mechanism: Electrically charged, and .the operator's choice of manual charging.

        1) Operating Handle: One for each circuit breaker capable of manual operation.
        2) Electric Close Button: One for each electrically operated circuit breaker. This control switch shall be a Series 31-B knob.
        3) All open and close buttons on the circuit breakers shall be equipped with a protective cover to prevent inadvertent operation.

d. Operation counter.

4. Trip Devices: Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:

   a. Provide trip devices which are interchangeable between compatible breaker frames. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. The rating plug shall be interlocked with the tripping mechanism to automatically "open" the breaker when the plug is removed. The breaker shall remain "trip free" with the plug removed. In addition, rating plugs shall be keyed to prevent incorrect application between different frame ratings.
   b. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
   c. Temperature compensation that ensures accuracy and calibration stability from minus 5 to plus 40 deg C. Circuit breakers shall have short circuit current withstands and interrupting ratings that meet or exceed 65kA symmetrical fault current.
   d. Field-adjustable, time-current characteristics.
   e. Current Adjustability: Dial settings and rating plugs on trip units, or sensors on circuit breakers, or a combination of these methods.
   f. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
   g. Pickup Points:

      1) Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I-squared-t operation.
      2) Five minimum, for instantaneous-trip functions.

   h. Ground-fault protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup.

      1) Arrange to provide protection for three-wire circuit or system.
      2) Arrange to provide protection for four-wire circuit or system.
      3) Arrange to provide protection for four-wire, double-ended substation.

5. The trip units shall utilize a Maintenance mode that shall reduce the trip unit Instantaneous pickup value when activated. The device shall not compromise breaker phase protection even when enabled. When Maintenance Mode is disabled, recalibration of the trip unit phase protection shall not be required. Activation and de-activation of the Maintenance Mode trip setting shall be accomplished without opening the circuit breaker door and exposing operators to energized parts. The Maintenance Mode trip settings shall be adjustable with a minimum of five settings ranging from 2.5X to 10X of the sensor value. The

ARMs shall be provided with a blue panel mounted selector switch with integral indication via a blue LED pilot light.

6. All trip units shall be provided with zone selective interlocking schemes.
7. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.
8. Auxiliary Contacts:

    a. Contacts and switches required for normal circuit-breaker operation, sufficient for interlocking and remote indication of circuit-breaker position.
    b. Spare auxiliary switches, at least two, unless other quantity is indicated. Each switch shall consist of two Type A and two Type B contacts wired through secondary disconnect devices to a terminal block in stationary circuit-breaker compartment.

9. Arc Chutes: Readily removable from associated circuit breaker when it is in "disconnected" position, and arranged to permit inspection of contacts without removing circuit breaker from switchgear.
10. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.
11. Circuit breakers shall contain a true two-step, stored energy mechanism providing quick-make, quick-break operation capable of charging-after-close operation. It shall be possible to discharge the closing springs without closing the main contacts. Maximum closing time shall be 5 cycles at nominal control voltage.
12. The tie breaker shall be identical to the main breakers and shall be capable of being exchanged with either main breaker.
13. A factory-installed "OFF" button padlock provision shall be included to prevent charging of the breaker mechanism when it is engaged.
14. Movement of the breaker handle alone shall not cause the breaker to change state (open or close).

H. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.

I. Key Interlocks: Arranged to prevent opening or closing interlocked circuit breakers, except in a specified sequence. Include mountings and hardware for future installation of key interlocks.

J. Sync Check Relays: Provide sync check relays on Main and Tie breakers to allow closing of breakers when both sides of breakers are synchronized or when closing into a dead bus. Sync check relays will also allow for closed transition transfer of sources.

K. PLC Interlock: Provide programming through PLC to prevent both main breakers and tei breaker being closed if the Howard Hall 15kV switchgear is being fed from two different BGE substations (one side from the north switching station and one side fed from the south switching station).

L. Local/Remote Switch: Provide a Local/Remote Switch on the switchgear. The Local/Remote switches shall prevent any remote control (automated or manually initiated from HMI) of the switchgear from the control system when in "Local". When Local/Remote switch is in "Local" the HMI shall display an alarm. Switch shall be pad-lockable. The Local/Remote switch shall be located on the switchgear for each specific bus. Provide Local/Remote Switches for the following:
   1. Howard Hall 480V Switchgear (One L/R Switch for both buses)
   2. Bressler Research Building 480V Switchgear (One L/R Switch for both buses)

M. Control Power:
   1. Manual spring charging operators and close and trip pushbuttons shall be accessible from the front of the circuit breaker when it is installed in a cubicle, with the cubicle door closed.
   2. The following circuit breaker operating status mechanical indicators at the front door of each circuit breaker compartment:

      a. Closing spring status (charged/discharged).
      b. Circuit breaker main contact status (open/closed).
      c. Circuit breaker drawout position (connect/test/disconnect).

   3. Standard padlocking provisions, on the front of the circuit breaker, to lock the circuit breaker open and mechanically trip-free. The padlock provision shall accept up to three padlocks with 1/4 to 3/8 inch diameter shank.
   4. Provide circuit breaker mechanism operated contacts (MOC) and truck operated contacts (TOC) as required for implementation of the specified control logic.
   5. Provide two spare sets of contacts that open when the circuit breaker is open and close when the circuit breaker closes (52a), and two spare sets of contacts that close when the circuit breaker is open and open when the circuit breaker closes (52b), wired through secondary disconnect devices to a terminal block in the stationary housing. Provide an auxiliary relay to provide additional "52a" and "52b" contacts for each breaker. Provide the maximum number of contacts allowable for each type.
   6. Circuit breakers shall be equipped with wheels that allow the circuit breaker to be rolled into the cubicle once it is installed on the drawout rails.

N. Undervoltage Trip Devices: Instantaneous, with adjustable pickup voltage and adjustable time delay.

O. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices. All indicating lights shall be LED type with push-to-test feature.
   1. Red – Closed
   2. Green – Open
   3. Amber/Blue/White – General Indication as required for interlocking.

2.6 LOW VOLTAGE INSTRUMENT SECTION

A. Instrument Transformers: Comply with IEEE C57.13.
   1. Potential Transformers: Secondary-voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y shall be provided on the bus side of the main breaker.
   2. Metering Current Transformers: Ratios as required for the application, burden, and accuracy class suitable for connected meters and instruments.
   3. Protection Current Transformers: Integral to circuit breaker rating plug assembly. Rating plugs shall be removable for increasing/decreasing trip unit rating without removing or replacing the trip unit itself.

B. Multifunction Digital-Metering Monitor: Provide Square-D PM5340 on 480V Main Breakers.
   1. Provide CT Shorting blocks located within the switchgear.

C. Control Wiring: Factory installed type SIS rated 600 volt, 90 degrees C, furnished with wire markers at each termination except where installation environments (temperature and chemical) require specialized insulation systems. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams complete with bundling, lacing, and protection. Complying with the following:
   1. Flexible stranded conductors for No. 12 AWG and larger.
   2. Minimum size of #14 AWG for 120VAC circuits, minimum size of #12 AWG for 125VDC circuits.
   3. All current transformer circuits shall be #10 AWG and wired through shorting type terminal blocks.
   4. All control wiring shall be 600V SIS. The use of nylon or PVC jackets is not acceptable.
   5. Each control wire shall be uniquely numbered at each end and at each termination point.
   6. No more than two wires shall be connected at a single wiring terminal. Thread on wire nuts or split bolt connectors are not permitted. In-line control wire splices are not acceptable.
   7. Terminal block shall be provided for all conductors requiring connection to circuits external to the specified equipment, where internal circuits cross shipping splits, and where equipment part replacement and maintenance will be facilitated.
   8. Leave slack in bundled conductors at hinges and interconnections between shipping units. Wiring traversing hinges or other forms of flexible constructions shall be high stranded and shall traverse the area of bending normal to the plane of rotation so as to impart a twisting rather than a bending motion to the cable or wire bundle.
   9. Short circuiting type terminal blocks shall be provided for shorting and grounding all CT leads. Non-short circuiting type terminal blocks shall be provided for terminating all control and protection leads.

10. All control wiring shall be routed through the low voltage compartments and secured using tie wraps.

2.7 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. Refer to 262313 Switchgear Controls and Automation Specification. Control system for 480V substations shall be fully integrated with Medium Voltage control system.

2.8 GRAPHIC TOUCHSCREEN INTERFACE PANEL (HMI)

A. Refer to 262313 Switchgear Controls and Automation Specification. Control system for 480V substations shall be fully integrated with Medium Voltage control system.

2.9 ACCESSORIES

A. Maintenance Tools: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.
   1. Racking handle to manually move circuit breaker between "connected" and "disconnected" positions. (Total of 4 per unit substation)
   2. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
   3. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.
   4. Circuit-Breaker Removal Apparatus: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.
   5. Remote Racking Device: Remote racking device capable of remotely inserting or removing the drawout circuit breakers while the operator is away from the switchgear. Device should operate off 120V receptacle.

B. Combination visual, UV, and IR scan windows shall be rectangular having an overall outside dimension of 12”W x 8.1”H with a window dimension of 9.3”W x 5”H. Window housing shall be aluminum with a locking cover and 316 stainless steel hardware. Optical material shall be a UL 746 compliant visual, UV, and IR transmissive polymer. Window shall be rated IP65/NEMA 4. Window shall be IRISS CAP-CT-12.

C. Ultrasound ports shall be round with a body diameter of 2.6” with a port diameter of 0.5”. Ports shall be made of UL 94 5VA nylon with a stainless steel cover. Ports shall be rated IP65/NEMA 4 when closed. Ports shall be IRISS VP-12-US.

2.10 IDENTIFICATION DEVICES

A. Compartment Nameplates: Engraved, laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.11 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90. Conduct switchgear and switchboard tests according to ANSI C37.51.
   1. The PLC programmer shall be available and present at the factory site during the full factory witness testing period so that any discovered issues or necessary modifications may be addressed at that time. The same PLC programmer shall be available during the complete site start-up and testing effort (see Part 3) and shall be present during the full site witness testing period so that any discovered issues or necessary modifications may be addressed at that time.
   2. Submit all test procedures for approval and notify the Project Manager thirty days prior to commencement of any tests. Testing shall be witnessed by the Owner, and/or their duly authorized representatives. Indicate the approximate duration of the tests.
   3. Provide four (4) copies of the factory test reports within two weeks of the completion of factory testing detailed herein.

B. Factory Tests: Perform the following factory-certified tests on each secondary unit substation:
   1. Transformer Tests (Where Transformer is Provided):
      a. Resistance measurements of all windings on the rated voltage connection and on tap extreme connections.
      b. Ratios on the rated voltage connection and on tap extreme connections.
      c. Polarity and phase relation on the rated voltage connection.
      d. No-load loss at rated voltage on the rated voltage connection.
      e. Exciting current at rated voltage on the rated voltage connection.
      f. Impedance and load loss at rated current on the rated voltage connection and on tap extreme connections.
      g. Applied potential.
      h. Induced potential.
      i. Temperature test is not required if a record of a temperature test on an essentially duplicate unit is available.
   2. Switchgear Tests:
      a. The switchgear shall be completely assembled, wired, adjusted and tested at the factory.

b. After assembly, the complete switchgear shall be tested to ensure the accuracy of the wiring and the functioning of all equipment.
c. The main bus system shall be given a dielectric test of 2200 volts for one minute between live parts and ground and between opposite polarities.
d. The wiring and control circuits shall be given a dielectric test of 1500 volts for one minute, or 1800 volts for one second, between live parts and ground, in accordance with ANSI C37.20.1.
e. Completely demonstrate the special provisions to accommodate switchgear maintenance.
f. A certified test report of all standard production tests shall be shipped with each assembly.
g. Verify mechanical operation; interlocks and interchangeability of selected breakers.

C. Factory Tests: A complete test of the custom PLC logic and other special features including actual operation of all the breakers in the switchgear to demonstrate all possible conditions of operation. All procedures for system configuration shall be demonstrated and testing shall include attempted operation of all breakers to verify proper interlocking.
1. Provide contactors as necessary to simulate interfacing PLC control of the 480V switchgear with the medium voltage switchgear. Refer to the Sequence of Operation Specification for requirements.

D. Owner will witness all required factory tests. Contractor to provide accommodations if more than 50 mi from site. Notify Owner at least 14 days before date of tests and indicate their approximate duration.
1. Attendance or non-attendance by the Owner and/or their duly authorized representatives at factory tests shall not relieve the manufacturer of responsibility to correct any defects or items of non-conformance with these specifications discovered during site testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of work.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions for secondary unit substation installation.

D. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at secondary unit substation location.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install secondary unit substations on concrete bases.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit and 4 inches high.
   2. Use 3,000-psi, twenty eight (28) day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Operating Instructions: Frame printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of secondary unit substation.

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.

B. Testing: Engage a qualified, NETA certified, independent testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test according to NETA ATS. Certify compliance with test parameters.
2. After installing secondary unit substation but before primary is energized, verify that grounding system at the substation tested at the specified value or less.
3. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.
4. Set field-adjustable switches and circuit-breaker trip ranges as indicated and per short circuit analysis and recommendations of coordination.

    a. Remove and replace malfunctioning units and retest as specified above.

C. Switchgear Field Tests:

1. Visual and Mechanical Inspection:

    a. Inspect physical and mechanical condition.
    b. Inspect anchorage, alignment, grounding, and required area clearances.
    c. Verify the unit is clean and shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
    d. Verify that fuse and circuit-breaker sizes and types correspond to Drawings and coordination study as well as to the address of the circuit breaker that is used to identify it in microprocessor-communication software.
    e. Verify that current and voltage-transformer ratios correspond to Drawings.
    f. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

        1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
        2) Make key exchange with devices operated in off-normal positions.

    g. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
    h. Inspect insulators for evidence of physical damage or contaminated surfaces.
    i. Verify correct barrier and shutter installation and operation.
    j. Exercise all active components.
    k. Inspect mechanical indicating devices for correct operation.

l. Verify that filters are in place and vents are clear.
m. Inspect control power transformers as follows:

1) Inspect for physical damage, cracked insulation, broken leads, connection tightness, defective wiring, and overall general condition.
2) Verify that primary- and secondary-fuse or circuit-breaker ratings match Drawings and comply with manufacturer's recommendations.
3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

n. A complete test of the custom PLC logic and other special features, including actual operation of all the breakers in the Load Center to demonstrate all possible conditions of operation. All procedures and the remote/local interlocks for system configuration shall be demonstrated and testing shall include attempted operation of all breakers to verify proper interlocking.

2. Electrical Tests:

a. Perform dc voltage insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute. If the temperature of the bus is other than plus or minus 20 deg. C, adjust the resulting resistance as provided in NETA ATS, Table 100.11.

1) Insulation-resistance values of bus insulation shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.1.
2) Do not proceed to the dielectric-withstand-voltage tests until insulation-resistance levels are raised above minimum values.

b. Perform a dielectric-withstand-voltage test on each bus section, each phase-to-ground with phases not under test grounded, according to manufacturer's published data. If manufacturer has no recommendation for this test, it shall be conducted according to NETA ATS, Table 100.2. Apply the test voltage for one minute.

1) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.

c. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with

solid-state components or control devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.

1) Minimum insulation-resistance values of control wiring shall not be less than 2 megohms.

d. Voltage Transformers:

1) Perform secondary wiring integrity test. Verify correct potential at all devices.
2) Verify secondary voltages by energizing the primary winding with system voltage.

e. Perform current-injection tests on the entire current circuit in each section of switchgear.

1) Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
2) Perform current tests by primary injection with magnitudes such that a minimum of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.

f. Verify operation of space heaters.
g. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.

D. Dry-Type Transformer Section Field Tests (Where Transformer is Provided):

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that any shipping brackets have been removed.
d. Verify the unit is clean.
e. Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
f. Verify that cooling fans operate and that fan motors have correct overcurrent protection.
g. Perform specific inspections and mechanical tests recommended by the manufacturer.
h. Verify that as-left tap connections are as specified.
i. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

   a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; the value of the index shall not be less than 1.0.
   b. Perform power-factor or dissipation-factor tests on windings according to the test equipment manufacturer's published data. Investigate and correct power-factor values that exceed:

      1) 2.0 percent for power transformers.
      2) 5.0 percent for distribution transformers.

   c. Measure core insulation resistance at 500-V dc if the core is insulated and the core ground strap is removable. Core insulation-resistance values shall not be less than 1 megohm at 500-V dc.
   d. Perform a power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV. Tip-up test result exceeding 1.0 percent shall be investigated.
   e. Perform turns-ratio tests at all tap positions. The test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If the test fails, replace the transformer.
   f. Perform an excitation-current test on each phase. The typical excitation-current test data pattern for a three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if the test shows a different pattern.
   g. Measure the resistance of each winding at each tap connection.
   h. Perform an applied-voltage test on all high- and low-voltage windings-to-ground. See IEEE C57.12.91, Sections 10.2 and 10.9. The ac dielectric-withstand-voltage test result shall not exceed 75 percent of factory test voltage for one-minute duration. The dc dielectric-withstand-voltage test result shall not exceed 100 percent of the ac rms test voltage specified in IEEE 57.12.91, Section 10.2, for one-minute duration. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.
   i. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

E. Low-Voltage Power Circuit-Breaker Field Tests:

1. Visual and Mechanical Inspection:

   a. Inspect physical and mechanical condition.
   b. Inspect anchorage, alignment, and grounding.

c. Verify that all maintenance devices are available for servicing and operating the breaker.
d. Verify the unit is clean.
e. Verify that the arc chutes are intact.
f. Inspect moving and stationary contacts for condition and alignment.
g. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
h. Perform mechanical operator and contact alignment tests on both the breaker and its operating mechanism according to manufacturer's published data.
i. Verify cell fit and element alignment.
j. Verify racking mechanism operation.
k. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
l. Perform adjustments for final protective-device settings according to coordination study provided by end user.
m. Record as-found and as-left operation counter readings.

2. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.1. Insulation-resistance values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations shall be investigated.
b. Measure contact resistance across each power contact of the circuit breaker. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
c. Determine long-time pickup and delay by primary current injection. Long-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are not available, trip times shall not exceed the value shown in NETA ATS, Table 100.7.
d. Determine short-time pickup and delay by primary current injection. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.

e. Determine ground-fault pickup and delay by primary current injection. Ground-fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
f. Determine instantaneous pickup value by primary current injection. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.8.
g. Test functions of the trip unit by means of secondary injection. Pickup values and trip characteristic shall be as specified and within manufacturer's published tolerances.
h. Perform minimum pickup voltage tests on shunt trip and close coils according to manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall conform to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
i. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
j. Verify correct operation of any auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, anti-pump function, and trip unit battery condition. Reset trip logs and indicators. Auxiliary features shall operate according to manufacturer's published data.
k. Verify operation of charging mechanism. The charging mechanism shall operate according to manufacturer's published data.

3.7 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each secondary unit substation. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5% during the test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

a. Adjust transformer taps.
b. Rebalance loads.
c. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
4. Report: Present field copy and prepare a written report covering monitoring performed and corrective action taken.

B. Infrared Scanning: Perform as specified in Division 26 Section "Medium-Voltage Switchgear."

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 261116

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SECTION 261200 - MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 DESCRIPTION OF WORK

A. This section provides the specification for the Medium-Voltage Transformers and related accessories that shall be furnished by the manufacturer.

1.3 DELIVERY

A. The supplier's shipping company shall verify all height, weight, and traffic limitations when considering pricing and actual delivery. The delivery at the site for the equipment unloading shall be scheduled for normal working hours of Monday through Friday (7:00am – 3:00pm). The actual delivery through the University of Maryland, Baltimore campus must be scheduled with the University to prevent travel through major campus activity days. The shipper shall consider that it may take up to 4 hours before the switchgear is lifted off the delivery truck and the truck is free to leave.

1.4 SUMMARY

A. This Section includes the following types of transformers with medium-voltage primaries:
   1. Dry-type distribution and power transformers.

1.5 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.6 SUBMITTALS

A. Compliance Statement as described under the Quality Assurance section of this specification.

B. Submittals:
   1. Shop Drawings: Diagram power, signal, and control wiring.
   2. Coordination Drawings: Floor 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:

      a. Dimensioned plan and elevations with tap, control power transformer, fan and temperature monitor locations, and phase, neutral and ground connection locations.
      b. Enclosure details, including removable panel descriptions, louver locations, control wiring routing, sheet metal gauge, and painting details.
      c. Terminal locations and details for phase, neutral and ground connections.
      d. Coil conductor materials and construction.
      e. Insulation materials.
      f. Test data sheets for similar transformers with test data on load losses, no-load losses and sound level.
      g. Temperature control system description, including details on the control power transformer, fans, temperature monitor, alarms and hinged panel for the monitor.
      h. Schematic and connection diagrams for the temperature control system.
      i. Full size copy of the nameplate.
      j. Coil-to-bus/line connection materials, support and details.
      k. Bus bar and line termination connection and support details.
      l. ANSI Damage curve for secondary unit substation transformers.
      m. Detailed location, mounting and wiring of the lightning arrestors.

   3. Qualification Data: For testing agency.
   4. Source quality-control test reports.
   5. Field quality-control test reports.
   6. Follow-up service reports.
   7. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Compliance Statement: The Manufacturer/Equipment Vendor shall include a Compliance Statement, listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as

defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of transformers and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C2 and NESC.

F. Comply with ANSI C57.12.10, ANSI C57.12.28, IEEE C57.12.70, and IEEE C57.12.80.

G. Comply with NFPA 70.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store transformers protected from weather so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

1.9 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of louvers, doors, spill retention areas, and sumps. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.

1.10 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. GE Electrical Distribution & Control.
2. Square D; Schneider Electric.
3. Virginia Transformer Corp.
4. ABB Power T&D Co. Inc.
5. Sunbelt Transformer
6. Waukesha Electric Systems, Inc.

2.2 DRY-TYPE DISTRIBUTION AND POWER TRANSFORMERS

A. Description: NEMA ST 20, IEEE C57.12.01, ANSI C57.12.51, UL 1562 listed and labeled, dry-type, two (2)_winding transformers. Provide indoor or outdoor rating as required on drawings.

1. Indoor, Transformer for Substation 8, BRB: Indoor, ventilated, cast coil/encapsulated coil, with primary and secondary windings individually cast in epoxy; with insulation system rated at 185^0C with an 80^0C average winding temperature rise above a maximum ambient temperature of 40^0C.
2. Outdoor, Transformers on Howard Hall Roof: Outdoor, ventilated, cast coil/encapsulated coil with primary and secondary windings individually cast in epoxy; with insulation system rated at 185 deg C with an 80 deg C average winding temperature rise above maximum ambient of 40 deg C.

B. Primary Connection: Air terminal compartment with hinged door. Tin-plated copper bar for incoming line termination, predrilled to accept terminals for indicated conductors.

C. Secondary Connection for outdoor transformers: Air terminal compartment with hinged door. Tin-plated copper bar for incoming line termination, predrilled to accept terminals for indicated conductors.

D. Secondary Connection for indoor, substation transformer: Transition terminal compartment with connection pattern to match switchgear.

E. Insulation Materials: IEEE C57.12.01, rated at 220^0C.

F. Insulation Temperature Rise: 115^0C, maximum rise above 40^0C.

G. Basic Impulse Level: 95kV.

H. Full-Capacity Voltage Taps: Four nominal 2.5% taps, two (2) above and two (2) below rated primary voltage.

I. Cooling System: Class AA/FA, self-cooled, and with forced-air-cooled rating, complying with IEEE C57.12.01.

J. Sound level may not exceed sound levels listed in NEMA TR 1, without fans operating.

K. Impedance: 5.75% +/-7.5% tolerance.

L. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm. Square-D, Model 98 Transformer Temperature Monitor for remote recording of transformer winding temperatures.

2.3 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to ANSI C57.12.51.

B. Factory Tests: Perform the following factory-certified tests on each transformer:

1. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
2. Ratios on rated-voltage connection and on tap extreme connections.
3. Polarity and phase relation on rated-voltage connection.
4. No-load loss at rated voltage on rated-voltage connection.
5. Excitation current at rated voltage on rated-voltage connection.
6. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
7. Applied potential.
8. Induced potential.
9. Temperature Test: If transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class OA/FA or Class AA/FA rating.

    a. Temperature test is not required if record of temperature test on an essentially duplicate unit is available.

10. Owner will witness all required factory tests. Notify Owner at least 14 days before date of tests and indicate their approximate duration.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install indoor transformers on concrete bases.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit and 4 inches high.
2. Use 3000-psi concrete twenty eight (28) day compressive-strength, and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."
3. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on eighteen (18) inch centers around full perimeter of base.
4. Install epoxy-coated anchor bolts, for supported equipment, that extend through concrete base and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Tack-weld or bolt transformers to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.

B. Transformers on roof will be installed on steel framing. Refer to structural drawings for requirements.

C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Connect wiring according to Division 26 Section "Medium-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

1. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
2. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform visual and mechanical inspection and electrical tests stated in NETA ATS. Certify compliance with test parameters.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Dry-Type Transformer Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that any shipping brackets have been removed.
d. Verify the unit is clean.
e. Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
f. Verify that cooling fans operate and that fan motors have correct overcurrent protection.
g. Perform specific inspections and mechanical tests recommended by the manufacturer.
h. Verify that as-left tap connections are as specified.
i. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; the value of the index shall not be less than 1.0.
b. Perform power-factor or dissipation-factor tests on windings according to the test equipment manufacturer's published data. Investigate and correct power-factor values that exceed:
c. 2.0 percent for power transformers.
d. 5.0 percent for distribution transformers.
e. Measure core insulation resistance at 500-V dc if the core is insulated and the core ground strap is removable. Core insulation-resistance values shall not be less than 1 megohm at 500-V dc.
f. Perform a power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV. Tip-up test result exceeding 1.0 percent shall be investigated.
g. Perform turns-ratio tests at all tap positions. The test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If the test fails, replace the transformer.
h. Perform an excitation-current test on each phase. The typical excitation-current test data pattern for a three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if the test shows a different pattern.
i. Measure the resistance of each winding at each tap connection.
j. Perform an applied-voltage test on all high- and low-voltage windings-to-ground. See IEEE C57.12.91, Sections 10.2 and 10.9. The ac dielectric-withstand-voltage test result shall not exceed 75 percent of factory test

voltage for one-minute duration. The dc dielectric-withstand-voltage test result shall not exceed 100 percent of the ac rms test voltage specified in IEEE 57.12.91, Section 10.2, for one-minute duration. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.

k. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

D. Remove and replace malfunctioning units and retest as specified above.

E. Test Reports: Prepare written reports to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

3.6 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: If requested by owner, perform the following voltage monitoring after Substantial Completion but not more than six months after Final Acceptance:

1. During a period of normal load cycles as evaluated by owner, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5% during test period, is unacceptable.
2. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:

a. Adjust transformer taps.

3. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.
4. Report: Prepare written report covering monitoring and corrective actions performed.

B. Infrared Scanning: Perform as specified in Division 26 Section "Medium-Voltage Switchgear."

END OF SECTION 261200

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SECTION 261300 - MEDIUM-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

A. This Section includes metal-clad, circuit-breaker switchgear with the following optional components, features, and accessories:

1. Copper, silver-plated main bus at connection points
2. Communication modules.
3. Relays.
4. Surge arresters.
5. Provisions for future devices.
6. Control battery system.
7. Mimic bus.

1.3 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. GFCI: Ground-Fault Circuit Interrupter.

1.4 SUBMITTALS

A. Product Data: For each type of switchgear and related equipment, include the following:

1. Rated capacities, operating characteristics, furnished specialties, and accessories for individual circuit breakers.
2. Time-current characteristic curves for overcurrent protective devices, including circuit-breaker relay trip devices.

B. General arrangement drawings of switchgear and accessories complete with dimensions. Include plan view and section view drawings. Indicate required clearances and overall dimensions.

C. Shop Drawings: For each type of switchgear and related equipment, include the following:

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show method of field assembly and location and size of each field connection. Include the following:

   a. Tabulation of installed devices with features and ratings.
   b. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
   c. Drawing of cable termination compartments showing preferred locations for conduits and indicating space available for cable terminations.
   d. Floor plan drawing showing locations for anchor bolts and leveling channels.
   e. Current ratings of buses.
   f. Short-time and short-circuit ratings of switchgear assembly.
   g. Nameplate legends.
   h. Mimic-bus diagram.
   i. Metering provisions with approval by Owner.

2. Wiring Diagrams: For each type of switchgear and related equipment, include the following:

   a. Power, signal, and control wiring.
   b. Three-line diagrams of current and future secondary circuits showing device terminal numbers and internal diagrams.
   c. Schematic control diagrams.
   d. Diagrams showing connections of component devices and equipment.
   e. Schematic diagrams showing connections to remote devices including SCADA remote terminal unit.

3. Circuit Breaker Control Schematics and Switchgear point to point wiring diagrams.
   a. Control and Protective relay diagrams including the following:
   b. Instrument transformer ratios, accuracy class, transformer wiring connections, and polarities.
   c. Control wiring size and type.
   d. All external wiring connections for each protective relay.
   e. All switchgear drawings prepared by the Equipment Vendor shall be submitted to the Engineer in AutoCAD format in addition to hard copy submittals. Electronic files to be submitted include:
   f. Circuit Breaker Control Schematics for each breaker cubical.
   g. Point to Point Wiring Diagrams for each switchgear cubical.
   h. Switchgear Three Line Diagrams.
   i. Switchgear Single Line Diagrams
   j. Schematic diagrams showing connections to remote devices including SCADA remote terminal unit.

D. Utility Review: The shop drawings will be submitted to the Utility for review and approval after review and approval by the Engineer. The manufacturer shall provide a compliance statement with the shop drawings as outlined in Section 1.5 of this specification for all requirements shown in the latest version of BGE CSR-2 which shall be considered part of the contract documents.

E. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where piping and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Identify field measurements.

F. Relay Electronic Files: Settings files in electronic format shall be provided for review and approval prior to factory witness testing. Default settings for all protective functions shall be provided for the initial review and for factory testing. The Engineer will provide the final set points to be implemented by the certified testing agent in the field.

G. Battery Calculations: Provide calculations showing battery size and quantity is sufficient for supplying all connected and planned future equipment as shown on the drawings.

H. Samples: Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.

I. Qualification Data: For testing agency.

J. Source quality-control test reports.

K. Field quality-control test reports.

L. Operation and Maintenance Data: For switchgear and switchgear components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device.
3. As-Left relay settings files in electronic format on a DVD or USB thumb drive – total of 4 copies.
4. As-Left PLC programming on a USB thumb drive with paper copies – total of 4 copies.
5. USB thumb drive with PLC programming software.

1.5 QUALITY ASSURANCE

A. Compliance Statement: The Manufacturer/Equipment Vendor shall include a Compliance Statement, listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

D. Source Limitations: Obtain each type of switchgear and associated components through one source from a single manufacturer.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with IEEE C2.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver in sections of lengths that can be moved past obstructions in delivery path as indicated.

B. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:

1. Ambient temperature not exceeding 122^0F

2. Altitude of 3300 feet above sea level.

B. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than 10 days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

3. Outages to existing loads shall occur during off hours.

a. If contractor elects to do outages or switchovers during normal hours then contractor shall submit a plan to be approved by the owner and provide temporary power at no additional cost.

1.8 COORDINATION

A. Coordinate layout and installation of switchgear and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.

B. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 EXTRA MATERIALS

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. Fuses: Two of each type and rating used. Include spares for future transformers, control power circuits, and fusible devices.
2. Indicating Lights: Two of each type installed.
3. Touchup Paint: One container of paint matching enclosure finish, each 0.5 pint.

B. Maintenance Tools: Furnish tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include the following:

1. Fuse-handling tool.
2. 15kV Ground set assembly of at least 8'-0" length with clamps at each end.
3. Extension rails, lifting device, transport or dockable dolly or mobile lift, and all other items necessary to remove circuit breaker from housing and transport to remote location.
4. Racking handle to move circuit breaker manually between connected and disconnected positions, and a secondary test coupler to permit testing of circuit breaker without removal from switchgear.
5. Spare fuse storage cabinet: with piano hinged doors and key lockable. Sized for above listed maintenance tools.

1.10 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the manufacturers specified.

2.2 MANUFACTURED UNITS

A. Description: Factory assembled and tested, and complying with IEEE C37.20.1 and BGE CSR-2.

B. Ratings: Suitable for application in 3-phase, 60-Hz, solidly grounded-neutral system.

C. System Voltage: 13.2 kV nominal; 15 kV maximum.

2.3 METAL-CLAD, CIRCUIT-BREAKER SWITCHGEAR

A. Available Manufacturers:
1. Eaton Corporation; Cutler-Hammer Products.
2. Square D; Schneider Electric.
3. Powercon

B. All medium-voltage switchgear covered in this section shall be supplied from one manufacturer/supplier.

C. Comply with IEEE C37.20.3.

D. Nominal Interrupting-Capacity Class: 1000 MVA.

E. Ratings: Comply with IEEE C37.04.

1. North Switching Station Main-Bus Rating: 2000 A, continuous.

2. Howard Hall and Paralleling Switchgear Main-Bus Rating: 1200 A, continuous.

F. Switchgear Assembly:

1. Switchgear enclosure, busbar assemblies, circuit breakers, metering, protection, and switchgear controls shall be factory assembled and tested, and shall have ratings as described in the paragraphs below, in accordance with the Standards listed in Part 1 of this Section.

2. The switchgear assembly shall consist of individual vertical sections housing various combinations of circuit breakers and auxiliaries, bolted to form a rigid metal-clad switchgear assembly. Metal side sheets shall provide grounded barriers between adjacent structures and solid removable metal barriers shall isolate the major primary sections of each circuit. The switchgear shall be arranged in a 2 high configuration, with two hinged rear covers furnished for each vertical section for circuit isolation and ease of handling.

3. The stationary primary contacts shall be silver-plated and recessed within insulating tubes. A steel shutter shall automatically cover the stationary primary disconnecting contacts when the breaker is in the disconnected position or out of the cell.

G. Circuit Breakers: Three-pole, single-throw, electrically operated, drawout-mounting units using three individual, vacuum-sealed interrupter modules and including the following features:

1. Designed to operate at rated voltage to interrupt fault current within its rating within three cycles of trip initiation. For systems with X/R ratio of 17 or less, transient voltage during interruption shall not exceed twice the rated line-to-ground voltage of the system.
2. Contact-Wear Indicator: Readily accessible to field maintenance personnel.
3. Minimum of six Type A and six Type B spare contacts.
4. Interchangeability: Circuit breakers are interchangeable with vacuum circuit breakers of same current and interrupting ratings.

a. North Switching Station:
1) Current Rating of Main Circuit Breaker: 2000 A.

2) Continuous Current Rating of Tie Circuit Breaker: 2000 A.
3) Continuous Current Rating of Feeder Circuit Breaker: 1200 A.

b. Howard Hall and Paralleling Switchgear:
1) Current Rating of Main Circuit Breaker: 1200 A.
2) Continuous Current Rating of Tie Circuit Breaker: 1200 A.
3) Continuous Current Rating of Feeder Circuit Breaker: 1200 A.

5. Operating Mechanism: Electrically charged, mechanically and electrically trip-free, stored-energy operated.

a. Closing speed of moving contacts to be independent of both control and operator.
b. Design mechanism to permit manual charging and slow closing of contacts for inspection or adjustment.

1) Control Power: 125V dc for closing and tripping.

c. Provide shunt trip capability independent of overcurrent trip.

d. Circuit breaker shall be capable of being operated and racked in with the door closed.

H. Test Accessories: Relay and meter test plugs.

I. Low-DC-Voltage Alarm: Switchgear shall have a monitor for dc control power voltage with a remote contact output and Factory set alarm value at 80% of full-charge voltage.

J. Grounding and Testing Device: Suitable for phasing out, testing, and grounding switchgear bus or feeder if device is installed in place of circuit breaker. Include the following:

1. Portable Grounding and Testing Device: Interchangeable with drawout-mounting, medium-voltage circuit breakers to provide interlocked electrical access to either bus or feeder or both for phasing; manually operated.
2. Protective Cover: Fabricated of heavy-duty plastic and fitted to device.
3. Approval of Grounding and Testing Device System: Obtain approval of final system design from utility company and agency designated by Owner to handle future maintenance of medium-voltage switchgear.

K. Circuit-Breaker Test Cabinet: Separately mounted and containing push buttons for circuit-breaker closing and tripping, control relay, fuses, and secondary coupler with cable approximately one hundred eight (108) inches long. Include a set of secondary devices for operating circuit breaker if removed from switchgear and moved near test cabinet. Include provision for storage of test and maintenance accessories in cabinet.
1. Provide power connection for test cabinet, including 125 VDC for breaker operation.

L. Utility Compartment for North Switching Station: Dedicated BGE metering compartments to be provided in accordance with BGE standard CSR-2 including, but not limited to:
   1. Provide mounting provisions for three (3) BGE surge arrestors. The surge arrestors will be furnished and installed by BGE. The switchgear manufacturer is responsible for providing the tap wire from the bus connection to the surge arrestor. The surge arrestor will be 10kV duty cycle, 8.4 kV MCOV metal-oxide distribution class.
   2. The phase arrangement shall be A, B, C from left to right, top to bottom and front to back when viewed from the front of the switchgear.
   3. The BGE metering compartment shall contain provisions for mounting the BGE revenue metering current and potential transformers, potential transformer fuses, and all necessary drilling and bolting hardware. The revenue metering current transformers, potential transformers, and potential transformer fuses will be furnished and installed by BGE.
      a. The current transformers provided by BGE will have the same dimensions as GE JKM-5.
      b. A completely isolated compartment shall be provided in the metering unit for the installation of the BGE revenue metering potential transformers.
      c. The potential transformers provided by BGE will have the same dimensions as GE type JVM-5.
   4. Each metering unit compartment housing the potential and current transformers shall be provided with an interior protective hinged screen barrier or metal panel to prevent inadvertent physical contact with any energized part with the metering cubicle door open. The interior hinged screen barrier of metal panels shall be bolted closed with captive fasteners or other acceptable latching devices.
   5. All primary connections from the switchgear bus to the current transformer terminals, from the switchgear bus to the potential transformer fuses, and from the fuses to the potential transformers shall be provided and installed by the manufacturer.
   6. Primary taps from the switchgear bus to the potential transformer fuses shall be connected to the switchgear bus on the supply side terminals of the current transformer primary bus connections.

2.4 CONTROL SYSTEM

A. Refer to 262313 Switchgear Controls and Automation Specification.

B. Control hardware and components shall be located out of the medium voltage switchgear in separate HMI/control cabinets as indicated on the drawings.

C. The Master Control Panel (MCP) shall be located in Howard Hall. The MCP shall contain a Master Auto/Manual (MAM) Switch that disables automated controls for the entire control system. HMI shall display an alarm when MAM switch is placed in Manual.

D. All Local Control Panels (LCPs) shall contain a physical Station Auto/Manual (SAM) Switch. The SAM switch shall disable automated controls for that station only. HMI shall display an alarm when SAM switch is placed in manual. There shall be SAM switches for the following Switchgear:
   1. Howard Hall 15kV Switchgear and Howard Hall Generator Paralleling Switchgear (One SAM switch controls both switchgear)
   2. Peaking Plant Paralleling Switchgear
   3. North Switching Station
   4. Howard Hall 480V Switchgear
   5. Bressler Research Building 480V Switchgear

E. In addition to the MAM and SAM switches, Local/Remote switches shall be provided. The Local/Remote switches shall prevent any remote control (automated or manually initiated from HMI) of the switchgear from the control system when in "Local". When Local/Remote switch is in "Local" the HMI shall display an alarm. Switch shall be pad-lockable. The Local/Remote switch shall be located on the switchgear for each specific bus. Provide Local/Remote Switches for the following:
   1. Howard Hall 15kV Switchgear (One L/R Switch for both buses)
   2. Howard Hall Generator Paralleling Switchgear (One L/R Switch for both buses)
   3. Peaking Plant Paralleling Switchgear (One L/R Switch for both buses)
   4. North Switching Station Bus NA
   5. North Switching Station Bus NB
   6. North Switching Station Bus NC
   7. North Switching Station Bus ND
   8. Howard Hall 480V Switchgear (One L/R Switch for both buses)
   9. Bressler Research Building 480V Switchgear (One L/R Switch for both buses)

F. Provide lockout procedure for all switchgear interface locations that include operation of MAM, SAM and L/R switches.

2.5 GENERATOR CONTROL FEATURES

A. Provide manual generator set voltage and frequency control via the HMI with digital synchronizing scopes.

B. Each power source breaker shall be provided with digital manual synchronizing scopes and associated (25) sync-check protective relays. The synchronizing scopes shall be displayed on each HMI for all sources on the system on individual screens for each source. Software protective relays are not acceptable for manual operation functions.

C. Manual operation at the minimum shall allow a single generator to be placed on the bus and to carry the facility loads on a single engine generator up to the engine generator capacity. Each generator shall have the capability to be manually placed on the bus.

D. Demonstrate to the facility personnel the capability to manually control an engine generator without the use of the automation system.

2.6 FABRICATION

A. Indoor Enclosure: Free-standing, self-supporting unit constructed of not less than 11 gauge sheet steel, free from cracks, dents, seams and other defects.

B. Finish: Manufacturer's standard gray finish over rust-inhibiting primer on phosphatizing-treated metal surfaces.

C. Main Bus: The main bus shall be copper with fluidized bed epoxy flame-retardant and track-resistant insulation. The bus supports between units shall be flame-retardant, track-resistant, cycloaliphatic epoxy. The switchgear shall be constructed so that all buses, bus supports, and connections shall withstand stresses that would be produced by currents equal to the momentary ratings of the circuit breakers. Insulated copper main bus shall be provided and have provisions for future extension. All bus joints shall be silver plated, to standard 0.1 mil thickness, bolted and insulated with easily installed boots. The bus shall be braced to withstand fault currents equal to or greater than the momentary rating of the switchgear. The temperature rise of the bus and connections shall be in accordance with ANSI standards and documented by design tests. All termination pads shall be equipped with grounding studs.

D. Ground Bus: Copper, minimum size 0.25 by 2 inches, full length of switchgear. The ground bus shall be extended out into the termination areas of each breaker compartment. Within the termination areas, the ground bus shall be sized to accommodate the terminations for the cable shields and the 4/0 AWG (600V) feeder ground cable and equipped with grounding studs.

E. Bus Insulation: Covered with flame-retardant insulation.

F. Shutters: Metal shutters drop into place as each circuit breaker is racked out, and separate the busbars from the circuit breaker compartment with a grounded metal barrier when the circuit breaker is withdrawn.

G. Bus Transition Unit: Arranged to suit bus and adjacent units.

H. Incoming-Line Unit: Arranged to suit incoming line.

I. Outgoing Feeder Units: Arranged to suit distribution feeders.

J. Auxiliary Compartments: Arranged to suit house meters, relays, controls, and auxiliary equipment; isolated from medium-voltage components.

K. Doors: Hinged front doors, in accordance with ANSI construction, for each circuit breaker and metering & control compartment, with drop-bar to keep the door open during servicing,

and fitted with padlocking attachment to prevent unauthorized access. Hinged rear doors, with three-point latching mechanism, drop-bar to keep the door open during servicing, and handle with lock. Provide 2 keys for each lock.

1. Provide a 4 inch minimum infra-red window in each rear door, positioned for optimal viewing of terminations and busbar/lug connections during thermographic surveying.

L. Control Wiring: Factory installed type SIS rated 600 volt, 90 degrees C, furnished with wire markers at each termination except where installation environments (temperature and chemical) require specialized insulation systems. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams complete with bundling, lacing, and protection. Complying with the following:

1. Flexible stranded conductors for No. 12 AWG and larger.

2. Minimum size of #12 AWG.

3. All current transformer circuits shall be #10 AWG and wired through shorting type terminal blocks.

4. All control wiring shall be 600V SIS cable. The use of nylon is not acceptable.

5. All cables shall be terminated on terminal blocks using AMP or Burndy ring type solid un-insulted barrel terminations.

6. Each control wire shall be uniquely numbered at each end and at each termination point.

7. No more than two wires shall be connected at a single wiring terminal. Thread on wire nuts or split bolt connectors are not permitted. In-line control wire splices are not acceptable.

8. Terminal block shall be provided for all conductors requiring connection to circuits external to the specified equipment, where internal circuits cross shipping splits, and where equipment part replacement and maintenance will be facilitated.

9. Leave slack in bundled conductors at hinges and interconnections between shipping units. Wiring traversing hinges or other forms of flexible constructions shall be high stranded and shall traverse the area of bending normal to the plane of rotation so as to impart a twisting rather than a bending motion to the cable or wire bundle.

10. All control cables entering enclosures shall be secured by their jackets to the enclosure support to provide strain relief for the cable wire terminations.

11. All terminal blocks shall be removable screw or stud type. Compression type blocks are not acceptable.

M. Key Interlocks: Arranged to effect interlocking schemes indicated.
   1. Description: Dual radial campus feeders will be routed from the north station switchgear installed under this project to the south station switchgear installed under a future contract. The circuit breakers must be interlocked such that either the two north station feeder breakers or the two south station feeder breakers can be closed at the same time, preventing paralleling of the two stations through the distribution feeders.

N. Provisions for Future Key Interlocks: Mountings and hardware required for future installation of locks, where indicated.

O. Indicating lights shall be LED type or equivalent. On the front of each circuit breaker cubicle, provide lights to indicate the following:

   1. Circuit breaker closed, Red Lens.

   2. Circuit breaker open, Green Lens.

   3. Other indicators, White, Blue or Amber Lenses as indicated on the drawings.

P. Circuit breaker control switches shall be pistol grip with trip, normal after trip, normal after close, and close contacts.

2.7 COMPONENTS

A. Main Bus: Copper, silver plated at connection points; full length of switchgear.

B. Ground Bus: Copper, silver plated or copper, tin plated; minimum size one quarter (1/4) inch by two (2) inches; full length of switchgear.

C. Bus Insulation: Covered with flame-retardant insulation.

D. Instrument Transformers: Comply with IEEE C57.13.

   1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.

   2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

E. Multifunction Digital-Metering Monitor:

   1. Acceptable Models:
      a. Main Breakers: Schneider Electric PowerLogic ION 9000T with small display screen.

b. Generator Breakers: Schneider Electric PowerLogic ION 7400 with small display screen.
c. All Other Breakers: Schneider Electric Power Logic ION 7400.

2. Provide quantity and location of meters as indicated on the Drawings. Meter shall be mounted so that the display is a maximum of 5 ft AFF.

3. Meters shall use Modbus TCP/IP over Ethernet for communication links.

4. Current transformer poles shall have shorting auxiliary contacts and all CT wiring shall be on shorting type terminal blocks.

5. Digital meter power supply shall be fused separately from protection and control components.

6. All associated metering equipment shall be installed in an isolated separate compartment to facilitate service while gear is energized including shorting blocks, disconnect for meter power, etc.

7. Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

8. Breaker Monitoring Inputs: Coordinate power supply for the 52a/TOC/86 inputs into the meter with the available voltage ratings for the inputs into the meter. Utilize meter's 24VDC power supply.

F. Relays: Comply with IEEE C37.90, integrated digital type; with test blocks and plugs. Basis of design for relaying is Schweitzer Engineering Laboratories (SEL) with types and functionality as shown on the drawings.

1. Provide relay test switches for each relay with shorting test blocks for all CT circuits. Test switches shall be all black with clear covers.

2. Provide relay input/ output cards as required for all inputs, outputs, and communications as shown on the drawings. At minimum, a communication card that accepts dual Ethernet inputs, a fiber input, and an irgb input are required. All spare card slots shall be provided with cards that include 4 digital inputs and 4 digital outputs.

3. For SEL 751 relays, provide 5" touchscreen model.

4. Contractor shall be responsible for providing all relay settings files in electronic format. The Engineer will provide set points for overcurrent, synchronization, and differential only. The settings files provided by the Contractor shall include all required parameters for mapping inputs/ outputs, trip equations, LED displays, event recording, and all functions required for the sequence of operations such as but not limited to undervoltage and underfrequency.

G. Remote Racking Device: Provide capability for remote racking. Provide remote racking device and components. Provide two remote racking devices (one for Howard Hall and one for North Switching Station).

H. Provision for Future Devices Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.

I. Control Power Supply: DC battery system with ratings as shown on the drawings. The DC battery system shall contain fully redundant battery strings and chargers, each capable of carrying the full DC load of the switchgear system.

J. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:

1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.
2. Conductors sized according to NFPA 70 for duty required.

2.8 CONTROL BATTERY SYSTEM

A. System Requirements: Battery shall have number of cells and ampere-hour capacity based on an initial specific gravity of 1.210 at 25^0C with electrolyte at normal level and minimum ambient temperature of 13^0C. Cycle battery before shipment to guarantee rated capacity on installation. Arrange battery to operate ungrounded.

B. Battery: Valve regulated lead acid type with Absorbent Glass Mat (VRLA AGM). System batteries shall be suitable for service at an ambient temperature ranging from minus 18^0C to 25^0C. Limit variation of current output to 0.8 % for each degree below 25^0C down to minus 8^0C.

C. Rack: Six-step rack with electrical connections between battery cells and between rows of cells; include two flexible connectors with bolted-type terminals for output leads. The batteries shall be horizontally stacked within the rack.

D. Accessories:

1. Thermometers with specific-gravity correction scales.
2. Hydrometer syringes.
3. Set of insulated socket wrenches and other tools required for battery maintenance.
4. Wall-mounting, nonmetallic storage rack fitted to store above items.
5. Set of cell numerals.

E. Charger: Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit shall automatically maintain output voltage within 0.5 % from no load to rated charger output current, with ac input-

voltage variation of plus or minus 10 percent and input-frequency variation of plus or minus 3 Hz. Other features of charger include the following:

1. DC ammeter.
2. DC Voltmeter: Maximum error of 5% at full-charge voltage; operates with toggle switch to select between battery and charger voltages.
3. Ground Indication: Two appropriately labeled lights to indicate circuit ground, connected in series between negative and positive terminals, with midpoint junction connected to ground by normally open push-button contact.
4. Capacity: Sufficient to supply steady load, float-charge battery between 2.20 and 2.25 V per cell and equalizing charge at 2.33 V per cell.
5. Charging-Rate Switch: Manually operated switch provides for transferring to higher charging rate. Charger operates automatically after switch operation until manually reset.
6. AC power supply is 208 V or 480 V as indicated on the drawings, 60 Hz, subject to plus or minus 10 % variation in voltage and plus or minus 3-Hz variation in frequency. After loss of ac power supply for any interval, charger automatically resumes charging battery. Charger regulates rate of charge to prevent damage due to overload and to prevent fuses or circuit breakers from opening.
7. Protective Feature: Current-limiting device or circuit, which limits output current to rating of charger but does not disconnect charger from either battery or ac supply; to protect charger from damage due to overload, including short circuit on output terminals.
8. Electrical Filtering: Reduces charger's audible noise to less than 26 dB.

F. Eyewash Station: Provide self-contained eye wash station outside of battery room as shown on the drawings.

2.9 IDENTIFICATION

A. Materials: Refer to Division 26 Section "Identification for Electrical Systems." Identify units, devices, controls, and wiring.

B. Mimic Bus: Continuous mimic bus applied to front of switchgear, arranged in single-line diagram format, using symbols and lettered designations consistent with approved final mimic-bus diagram.

1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
2. Medium: Painted graphics, as approved.
3. Color: Contrasting with factory-finish background; selected by Architect.

C. Each cubicle of the switchgear must have a yellow sign with black lettering stating: “CUSTOMER OWNED SWITCHGEAR”. The sign shall be a minimum of 5” wide by 3”

high and shall be placed on the door under the breaker operating control switch. The sign shall be placed in the same relative position on the revenue metering cubicles.

2.10 SOURCE QUALITY CONTROL

A. Provide copies of all PLC Programs on a thumb-drive and paper copies for each electric station/switchgear location.

B. Factory Tests: Perform design and routine tests according to standards specified for components.
   1. The PLC programmer shall be available and present at the factory site during the full factory witness testing period so that any discovered issues or necessary modifications may be addressed at that time. The same PLC programmer shall be available during the complete site start-up and testing effort (see Part 3) and shall be present during the full site witness testing period so that any discovered issues or necessary modifications may be addressed at that time.
   2. Submit all test procedures for approval and notify the Project Manager thirty days prior to commencement of any tests. Testing shall be witnessed by the Owner, and/or their duly authorized representatives. Indicate the approximate duration of the tests.
   3. Provide four (4) copies of the factory test reports within two weeks of the completion of factory testing detailed herein.

C. Before shipment of equipment, perform the following tests and prepare test reports:

   1. Production tests on circuit breakers according to ANSI C37.09.
   2. Production tests on completed switchgear assembly according to IEEE C37.20.2.
   3. Include complete point-to-point check for all switchgear wiring.

D. Assemble switchgear and equipment in manufacturer's plant and perform the following:

   1. Functional tests of all relays, instruments, meters, and control devices by application of secondary three-phase voltage to voltage circuits and injection of current in current transformer secondary circuits.
   2. Functional test of all control and trip circuits. Connect test devices into circuits to simulate operation of controlled remote equipment such as circuit-breaker trip coils, close coils, and auxiliary contacts. Test proper operation of relay targets.

E. Prepare equipment for shipment and ship equipment to jobsite.

   1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
   2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

F. Factory Tests: A complete test of the custom PLC logic and other special features including actual operation of all the breakers in the switchgear to demonstrate all possible conditions of operation. All procedures for system configuration shall be demonstrated and testing shall include attempted operation of all breakers to verify proper interlocking.
   1. Provide contactors as necessary to simulate interfacing PLC control of the 480V switchgear with the medium voltage switchgear. Refer to the Sequence of Operation Specification for requirements.

G. Owner will witness all required factory tests. Contractor to provide accommodations if more than 50 mi from site. Notify Owner at least 14 days before date of tests and indicate their approximate duration.
   1. Attendance or non-attendance by the Owner and/or their duly authorized representatives at factory tests shall not relieve the manufacturer of responsibility to correct any defects or items of non-conformance with these specifications discovered during site testing.

2.11 FACTORY FINISHES

A. Finish: Manufacturer's standard color finish applied to equipment before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive switchgear for compliance with requirements for installation tolerances, required clearances, and other conditions affecting performance.

   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Anchor switchgear assembly to four (4) inch, channel-iron sill embedded in concrete baseand attach by bolting.

   1. Sills: Select to suit switchgear; level and grout flush into concrete base.

   2. Concrete Bases: Four (4) inches high, reinforced, with chamfered edges. Extend base no less than three (3) inches in all directions beyond the maximum dimensions of switchgear, unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchgear units and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Diagram and Instructions:

1. Frame under clear acrylic plastic on front of switchgear.

    a. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.
    b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.
    c. Laminated copy of Switchgear Sequence of Operations including instructions on how to operate switchgear.

2. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

3.4 CONNECTIONS

A. Cable terminations at switchgear are specified in Division 26 Section "Medium-Voltage Cables."

B. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Sections "Low-Voltage Electrical Power Conductors and Cables" and "Medium-Voltage Cables."

E. Connect multifunction digital-metering monitor according to Division 26 Section “Electrical Power Monitoring.”

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect switchgear, wiring, components, connections, and equipment installation. Test and adjust components and equipment.
2. Assist in field testing of equipment.
3. Report results in writing. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Testing Agency: Engage a qualified, NETA certified, independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
1. The Testing Agency shall be responsible for inputting the final relay protection set points provided by the Engineer in the field.

D. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:

a. Switchgear.
b. Circuit breakers.
c. Protective relays.
d. Instrument transformers.
e. Metering and instrumentation.
f. Ground-fault systems.
g. Battery systems.
h. Surge arresters.
i. Capacitors.
j. SCADA and automation equipment.

E. Remove and replace malfunctioning units and retest as specified above.

F. Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear eleven (11) months after date of Substantial Completion.
2. Instrument: Use an infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes infrared-scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of switchgear. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair damaged finishes.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturers stipulated service conditions.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear. Refer to Division 01 Section "Demonstration and Training."
   1. Include operation of remote racking device, control system operation, and generator starting and manual syncing.

END OF SECTION 261300

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SECTION 261301 – 4,160V MEDIUM-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 DESCRIPTION OF WORK

A. This section provides the specification for the Medium-Voltage Switchgear and related accessories that shall be furnished by the manufacturer.

1.3 DELIVERY

A. The supplier's shipping company shall verify all height, weight, and traffic limitations when considering pricing and actual delivery. The delivery at the site for the equipment unloading shall be scheduled for normal working hours of Monday through Friday (7:00am – 3:00pm). The actual delivery through the University of Maryland, Baltimore campus must be scheduled with the University to prevent travel through major campus activity days. The shipper shall consider that it may take up to 4 hours before the switchgear is lifted off the delivery truck and the truck is free to leave.

1.4 SUMMARY

A. This Section includes metal-enclosed, fused switchgear with the following optional components, features, and accessories:

1. Copper, silver-plated main bus at connection points.
2. Mimic bus.

1.5 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. GFCI: Ground-Fault Circuit Interrupter.

1.6 SUBMITTALS

A. Provide compliance statement as described under the Quality Assurance section of this Specification.

B. Submittals:
   1. Product Data: For each type of switchgear and related equipment, include the following:

      a. Rated capacities, operating characteristics, furnished specialties, and accessories for individual circuit breakers.
      b. Time-current characteristic curves for overcurrent protective devices, including power fuses.

   2. General arrangement drawings of switchgear and accessories complete with dimensions. Include plan view and section view drawings. Indicate required clearances and overall dimensions.
   3. Single line diagrams.
   4. Shop Drawings: For each type of switchgear and related equipment, include the following:

      a. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show method of field assembly and location and size of each field connection. Include the following:

         1) Tabulation of installed devices with features and ratings.
         2) Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
         3) Drawing of cable termination compartments showing preferred locations for conduits and indicating space available for cable terminations.
         4) Floor plan drawing showing locations for anchor bolts and leveling channels.
         5) Current ratings of buses.
         6) Short-time and short-circuit ratings of switchgear assembly.
         7) Nameplate legends.
         8) Mimic-bus diagram.
         9) Metering provisions with approval by Owner.

      b. Wiring Diagrams: For each type of switchgear and related equipment, include the following:

         1) Power, signal, and control wiring.
         2) Three-line diagrams of current and future secondary circuits showing device terminal numbers and internal diagrams.

3) Schematic control diagrams.
4) Diagrams showing connections of component devices and equipment.
5) Schematic diagrams showing connections to remote devices including SCADA remote terminal unit.

c. Control Schematics and Switchgear point to point wiring diagrams.

1) Control and Protective relay diagrams including the following:
   a) Instrument transformer ratios, accuracy class, transformer wiring connections, and polarities.
   b) Control wiring size and type.
   c) All external wiring connections for each protective relay.
2) All switchgear drawings prepared by the Equipment Vendor shall be submitted to the Engineer in AutoCAD format in addition to hard copy submittals. Electronic files to be submitted include:
   a) Control Schematics for each cubical.
   b) Point to Point Wiring Diagrams for each switchgear cubical.
   c) Switchgear Three Line Diagrams.
   d) Switchgear Single Line Diagrams
3) Schematic diagrams showing connections to remote devices including SCADA remote terminal unit.

5. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where piping and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Identify field measurements. Include layout of battery room.
6. Samples: Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.
7. Qualification Data: For testing agency.
8. Source quality-control test reports.
9. Field quality-control test reports.
10. Operation and Maintenance Data: For switchgear and switchgear components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
    a. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
    b. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.7 QUALITY ASSURANCE

A. Compliance Statement: The Manufacturer/Equipment Vendor shall include a Compliance Statement, listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating,

paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain each type of switchgear and associated components through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C2.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver in sections of lengths that can be moved past obstructions in delivery path as indicated.

B. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:

1. Ambient temperature not exceeding 122^0F
2. Altitude of 3300 feet above sea level.

B. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than 10 days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

3. Outages to existing loads shall occur during off hours.

a. If contractor elects to do outages or switchovers during normal hours then contractor shall submit a plan to be approved by the owner and provide temporary power at no additional cost.

1.10 COORDINATION

A. Coordinate layout and installation of switchgear and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.

B. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.11 EXTRA MATERIALS

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. Fuses: Two of each type and rating used. Include spares for future transformers, control power circuits, and fusible devices.
2. Indicating Lights: Two of each type installed.
3. Touchup Paint: One container of paint matching enclosure finish, each 0.5 pint.

1.12 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the manufacturers specified.

2.2 MANUFACTURED UNITS

A. Description: Factory assembled and tested, and complying with IEEE C37.20.1.

B. Ratings: Suitable for application in 3-phase, 60-Hz, solidly grounded-neutral system.

C. System Voltage: 13.2 kV nominal; 15 kV maximum.

D. Available Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. Schneider Electric, Inc.

2.3 INCOMING SECTION

A. Primary Incoming Section: Close-coupled, enclosed, load break, air-interrupter or SF6 gas insulated primary switch.

1. Three pole, single throw, dead front, metal enclosed, with manual stored energy operator, with fuses, complying with IEEE C37.20.3.
2. Key interlocking system to prevent fuse access door from being opened unless switch is open. Lock cylinders shall use BEST access systems key cylinders with removable 7-pin cores. Spare keys shall be provided to the University and shall permit the opening of the fuse compartment door with the switch closed.
3. Insulation: All medium voltage connections, bus bars and devices in switches shall be insulated. Insulated barriers shall not be allowed to come in contact with insulated conductors and shall maintain a 3 inch clearance. A minimum of 6 inch clearance shall be observed between insulated and uninsulated barriers from uninsulated conductors.
4. Phase Barriers: Located between blades of each phase, designed for easy removal, allows visual inspection of switch components when barrier is in place.
5. Window: Permits viewing switch-blade positions when door is closed. Air break primary switches shall have a 6 inch minimum break between contacts.

6. Switch contact status for gas insulated switches shall be derived from positive position sensing of the primary contacts and be visually inspectable with the switch energized.
7. The switch shall be constructed with the switch above the fuses. The switch blades shall pivot on the bottom (load side) of the switch. Provide bussing from the top of the switch for cable entrance from the bottom.
8. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.
9. Voltage: 15kV Nominal
10. Continuous-Current Rating: 600 A.
11. Short-Circuit Rating:

    a. 2-second symmetrical rating of 38-kA RMS.
    b. Fault close asymmetrical rating of 61 kA.

12. Fuses shall be E type clip style fuses sized as indicated on the drawings.
13. Switch handles shall face the front of the enclosure and shall have provisions for padlocks in both the open and closed positions.
14. The switches shall be capable of being operated with the operator staffing safely away from the front of the switch.
15. Front compartment doors shall be hinged and provisions for padlocks. Rear panels shall be bolted.
16. The switches shall be rated electrically and mechanically for a minimum of 1,000 load break operations.
17. The switches shall not have floor plates.
18. The switches shall be constructed to provide safe access to terminals without de-energizing the switch. Switches and bussing shall use porcelain insulators throughout the compartments.
19. Switch operating mechanisms which use chains are not permitted.
20. Unshielded 15kV cable shall be trained and properly supported to provide a minimum of 1 ½" inches to any grounded part.
21. Provide ground ball studs on all phase and ground buses.
22. All terminations shall be crimp style connections utilizing 2 hole long barrel lugs.

2.4 DRY-TYPE TRANSFORMER SECTION

A. Refer to Specification 261200 Medium-Voltage Transformers for requirements.

2.5 SWITCHGEAR

A. Comply with IEEE C37.20.7.

B. Ratings: Comply with IEEE C37.04.

1. Rated Maximum Voltage and BIL: 4.76 kV, 60 kV
   a. Rated Continuous Current: 1200 A
   b. Rated Momentary Withstand Current (600 A and 1200 A Continuous Current Ratings): 40 kA asym rms for 10 cycles.
   c. Rated Short-Time Withstand Current (600 A and 1200 A Continuous Current Ratings): 25 kA sym rms for 2 s.
2. Non-Fused Load Interrupter Switch:
   a. Rated Continuous Current and Load Switching Current: 600 A
   b. Rated Momentary Withstand Current: 40 kA asym rms for 10 cycles.
   c. Rated Fault Close Withstand Current: 61 kA asym.
   d. Rated Short-Time Withstand Current: 38 kA sym rms for 2 s.
3. Fused Switches with Current Limiting Fuses:
   a. Fuse Type and Rated Continuous Current: See drawings.
   b. Fuse Interrupting Rating: 63 kA sym rms.

C. Switchgear Assembly:

1. Switchgear enclosure, busbar assemblies, switches, metering, protection, and switchgear controls shall be factory assembled and tested, and shall have ratings as described in the paragraphs below, in accordance with the Standards listed in Part 1 of this Section.
2. Deadfront, metal-enclosed, fixed-mount, fusible interrupter switchgear assembly of vertical sections.
   a. Front and rear access switchgear.
   b. Viewing window to show view of the position of the three poles of the interrupter.
   c. Mechanical interlock preventing the door from opening when the switch is open and requiring the door to be closed before the switch can be closed.
   d. Padlocking and tagging the switch in the opened or closed position.
   e. Switch position indicator.
   f. Front and rear vertical section covers shall have full-length hinges. The front cover shall be a flanged door with latching hardware. The rear cover may be bolted.
3. Switches: Load interrupter type, with fuses. Omit fuses where specifically indicated.
   a. Switch Operator: Manual.
   b. Switch Construction:
      1) Grounded, metal shield to cover live components and terminals.
      2) Supported entirely by interior framework of structure, with copper switchblades and stored-energy operating mechanism.
      3) Phase barriers, full length of switchblades and fuses for each pole; readily removable and replaceable; designed to allow visual inspection of switch components when barrier is in place.
   c. Fuses:

1) Installed on a single mounting frame, de-energized when the switch is open.
2) Current-Limiting Fuses: Full-range, fast-replaceable, current-limiting type that will operate without explosive noise or expulsion of gas, vapor, or foreign matter from tube.
3) Indicator integral with each fuse to show when it has blown.
4) Spares: Include three fuses in use and three spare fuses in storage clips in each switch.

2.6 FABRICATION

A. Indoor Enclosure: Steel.

B. Finish: Manufacturer's standard gray finish over rust-inhibiting primer on phosphatizing-treated metal surfaces.

C. Main Bus: The main bus shall be copper with fluidized bed epoxy flame-retardant and track-resistant insulation. The bus supports between units shall be flame-retardant, track-resistant, cycloaliphatic epoxy. The switchgear shall be constructed so that all buses, bus supports, and connections shall withstand stresses that would be produced by currents equal to the momentary ratings of the circuit breakers. Insulated copper main bus shall be provided and have provisions for future extension. All bus joints shall be silver plated, to standard 0.1 mil thickness, bolted and insulated with easily installed boots. The bus shall be braced to withstand fault currents equal to or greater than the momentary rating of the switchgear. The temperature rise of the bus and connections shall be in accordance with ANSI standards and documented by design tests. All termination pads shall be equipped with grounding studs.

D. Ground Bus: Copper, minimum size 0.25 by 2 inches, full length of switchgear. The ground bus shall be extended out into the termination areas of each breaker compartment. Within the termination areas, the ground bus shall be sized to accommodate the terminations for the cable shields and the 4/0 AWG (600V) feeder ground cable and equipped with grounding studs.

E. Bus Insulation: Covered with flame-retardant insulation.

F. Bus Transition Unit: Arranged to suit bus and adjacent units.

G. Incoming-Line Unit: Arranged to suit incoming line.

H. Outgoing Feeder Units: Arranged to suit distribution feeders.

I. Auxiliary Compartments: Arranged to suit house meters, relays, controls, and auxiliary equipment; isolated from medium-voltage components.

2.7 COMPONENTS

A. Instrument Transformers: Comply with IEEE C57.13.

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.

2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

a. Current Transformers for Differential Bus and Line Protection: Provide ANSI C200 accuracy class. All differential protection CTs shall have identical model numbers from the same manufacturer, and shall have identical ratios.

B. Metering:

1. Acceptable Models:

a. Main Switch: Schneider Electric PM8240.

2. Refer to 260913 Electrical Power Monitoring and Control specification for detailed requirements for meters.
3. Provide quantity and location of meters as indicated on the Drawings. Meter shall be mounted so that the display is a maximum of 5 ft AFF.
4. Meters shall use Modebus TCP/IP over Ethernet for communication links. Daisy chain meters together and report load data back to the Howard Hall Metering Network Switch.
5. Current transformer poles shall have shorting auxiliary contacts and all CT wiring shall be on shorting type terminal blocks.
6. If the meter does not have a meter serial number on the front of the display, then an engraved nameplate shall be installed below the meter displaying the meter serial number.
7. Provide “Certificate of Compliance and Calibration” for each meter, which provides test tracing back to (NIST).
8. Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.
9. Warranty Terms for Meters:
   a. The Equipment Vendor shall guarantee for twenty four (24) months from equipment startup or thirty (30) months from date of shipment, whichever occurs first, that the equipment shall be free from defects in design, workmanship or materials.
   b. In the event a component fails to perform as specified or is proven defective in service during the warranty period, the Contractor shall promptly repair or replace the defective part at no cost to the University.

10. Meters and associated CT's shall be revenue grade.
11. Meter inputs shall consist of 2 PT inputs and 3 CT inputs.

2.8 IDENTIFICATION

A. Materials: Refer to Division 26 Section "Identification for Electrical Systems." Identify units, devices, controls, and wiring.

B. Mimic Bus: Continuous mimic bus applied to front of switchgear, arranged in single-line diagram format, using symbols and lettered designations consistent with approved final mimic-bus diagram.

1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
2. Medium: Painted graphics, as approved.
3. Color: Contrasting with factory-finish background; selected by Engineer.

C. Compartment Nameplates: Engraved, laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws.

D. The Equipment Vendor shall be responsible for identifying all controls and wiring installed at the factory.

1. Each control wire terminal shall be identified with a unique number. Each control wire shall be identified on each end with a number matching the switchgear terminal number.
2. Devices shall be labeled inside the cabinets with the ANSI device number and the circuit number. Labels shall be self-adhesive, engraved, laminated, acrylic or melamine label with white letters on a black background. Minimum letter height shall be 3/8 inch.

2.9 SOURCE QUALITY CONTROL

A. Perform production tests, on each circuit breaker supplied for this Project, complying with IEEE C37.20.4.

1. Perform mechanical operation tests to ensure proper functioning of the switch.
2. Verify the contact gap. Perform terminal-to-terminal resistance test.
3. Verify that control wiring is correct by verifying continuity. Perform electrical operation of relays and devices to ensure they function properly and in the intended sequence.
4. Perform the control wiring dielectric test at 1500 V for one minute.

B. Assemble switchgear and equipment in manufacturer's plant and perform the following:

1. Functional tests of all instruments, meters, and control devices by application of secondary three-phase voltage to voltage circuits and injection of current in current transformer secondary circuits.
2. Functional test of all control and trip circuits. Connect test devices into circuits to simulate operation of controlled remote equipment such as circuit-breaker trip coils, close coils, and auxiliary contacts. Test proper operation of relay targets.

C. Prepare equipment for shipment and ship equipment to jobsite.

1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

D. Owner will witness all required factory tests. Contractor to provide accommodations if more than 50 mi from site. Notify Owner at least 14 days before date of tests and indicate their approximate duration.

1. Attendance or non-attendance by the Owner and/or their duly authorized representatives at factory tests shall not relieve the manufacturer of responsibility to correct any defects or items of non-conformance with these specifications discovered during site testing.

2.10 FACTORY FINISHES

A. Finish: Manufacturer's standard color finish applied to equipment before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive switchgear for compliance with requirements for installation tolerances, required clearances, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Anchor switchgear assembly to four (4) inch, channel-iron sill embedded in concrete base and attach by bolting.

1. Sills: Select to suit switchgear; level and grout flush into concrete base.

2. Concrete Bases: Four (4) inches high, reinforced, with chamfered edges. Extend base no less than three (3) inches in all directions beyond the maximum dimensions of switchgear, unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchgear units and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Diagram and Instructions:

1. Frame under clear acrylic plastic on front of switchgear.

a. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.
b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.

2. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

3.4 CONNECTIONS

A. Cable terminations at switchgear are specified in Division 26 Section "Medium-Voltage Cables."

B. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Sections "Low-Voltage Electrical Power Conductors and Cables" and "Medium-Voltage Cables."

E. Connect multifunction digital-metering monitor according to Division 26 Section “Electrical Power Monitoring.”

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect switchgear, wiring, components, connections, and equipment installation. Test and adjust components and equipment.
2. Assist in field testing of equipment.
3. Report results in writing. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Testing Agency: Engage a qualified, NETA certified, independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

D. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:

a. Switchgear.
b. Fused switches.
c. Protective relays.
d. Instrument transformers.
e. Metering and instrumentation.

E. Remove and replace malfunctioning units and retest as specified above.

F. Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear eleven (11) months after date of Substantial Completion.
2. Instrument: Use an infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes infrared-scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of switchgear. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair damaged finishes.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturers stipulated service conditions.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 261301

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SECTION 261302 - SEQUENCE OF OPERATION FOR ELECRICAL EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Refer to section 262313 Switchgear Controls and Automation for description of control system requirements and for Generator Startup Sequences.

1.2 SUMMARY

A. This Section includes control sequences and acceptance testing criteria for the electrical systems, which are composed of the following subsystems (as identified on the single-line diagrams):

1. North Switching Station
2. Future South Switching Station
3. Howard Hall 15kV Switchgear
4. Howard Hall Generator Paralleling Switchgear
5. Peaking Plant Paralleling Switchgear
6. Howard Hall 480V Switchgear
7. Bressler Research Building 480V Switchgear

B. Related Sections include the following:

1. Section 261116 “Secondary Unit Substations”
2. Section 261300 "Medium Voltage Switchgear"
3. Section 262313 “Switchgear Controls and Automation”
4. Section 263213 “Engine Generators”

C. System Description: The following sequence of operations shall be implemented and designed by the Power System Integrator in conjunction with the Medium Voltage Switchgear manufacturer via PLC based control and HMI screens. Refer to specification 262313 "Switchgear Controls and Automation" for control system and Power System Integrator requirements. In general, the control system shall accommodate the following functionality:

1. Automatic source transfer both for loss of utility and for individual bus or breaker failure.

2. Remote operation and monitoring of all circuit breakers. The circuit breaker operation will only be included as part of the sequence of operations and not as a manual digital pushbutton for user operation.

3. Engine control including:

    a. Engine Start, Stop, Control, and Paralleling

D. Generator Interface: The control system shall fully integrate with the new Peaking Plant generator controllers and existing HSF3 switchgear control system.

1. Contractor Requirements:

    a. Procure the services of GE to review the existing HSFIII GE Control System, review the existing sequence of operations, and perform all modifications necessary for integrating with the new automation system.

    b. Coordinate all system modifications at HSFIII and the Peaking Plant to maintain control power at the Peaking Plant. Control power and wetting current at the Peaking Plant is provided by HSFIII.

2. Control System Integrator Requirements:

    a. Integrate the existing GE Control System to the new automation system to receive HSFIII generator start/stop run statuses. This start/stop signal status shall be utilized by the new automation system as part of the system status check to the health of normal power available at HSFIII and the North Switching Station to determine automated breaker operations. HSFIII shall always have priority with the Peaking Plant generation and the Peaking Plant generators shall provide automatic standby power to HSFIII no matter the health of the normal Campus power source.

E. Future Equipment: This system shall be designed for integration of future South Switching Station. In addition, the system shall be expandable to include future generators and future 15kV and 480V building switchgear/substations.

1.3 DEFINITIONS AND ABBREVIATIONS

A. CB: Circuit Breaker

B. HMI: Human Machine Interface.

C. Loss of Voltage: Voltage level below an adjustable minimum level (50% to 100% Nominal Voltage) for an adjustable time period.

D. MOC: Mechanism Operated Contacts used to indicate circuit breaker position. MOC-a = contact open when breaker open, MOC-b = contact closed when breaker open.

E. Normal Power: Served by the utility source, but with standby generator backup.

F. Operator: the control system user.

G. Overvoltage: Voltage level above an adjustable minimum level (100% to 120% Nominal Voltage) for an adjustable time period.

H. PLC: Programmable Logic Controller

I. PT: Potential Transformer

J. Source Switching Station: The Switching Station that is currently aligned to feed the Howard Hall 15kV Switchgear. Either the North or South Switching Station.

K. System Control Screen: The control screen currently being accessed by the Operator, either an HMI screen at the switchgear, or a PC screen in the Central Plant control room.

L. Stable Voltage: Voltage level above an adjustable minimum level for an adjustable time period.

M. Switchgear Control System: The system of PLC's, input/output devices, communication devices, etc. used to control the 13.8kV switchgear and generators.

N. TOC: Truck Operated Contacts used to indicate breaker racked-in status. TOC-a contact closed when breaker is racked in, TOC-b = contact open when breaker is racked in.

O. Breaker Designations: refers to position of circuit breakers:

1. North Switching Station, Bus A
    a. NMA: Main breaker, Bus A
    b. N1A: Campus Feeder 1A
    c. N2A: Campus Feeder 2A
    d. N3A: Campus Feeder 3A
    e. N4A: Campus Feeder 4A
    f. N5A: Campus Feeder 5A
    g. N6A: Campus Feeder 6A
    h. N7A: Campus Feeder 7A (Future)
    i. NTA: Tie breaker to Bus NB
2. North Switching Station, Bus B
    a. NMB: Main breaker, Bus B
    b. N1B: Campus Feeder 1B
    c. N2B: Campus Feeder 2B
    d. N3B: Campus Feeder 3B
    e. N4B: Campus Feeder 4B
    f. N5B: Campus Feeder 5B
    g. N6B: Campus Feeder 6B
    h. N7B: Campus Feeder 7B (Future)
    i. NTB: Tie breaker to Bus NC
3. North Switching Station, Bus C
    a. NMC: Main breaker, Bus C
    b. N1C: Campus Feeder 1C

c. N2C: Campus Feeder 2C

d. N3C: Campus Feeder 3C

e. N4C: Campus Feeder 4C

f. N5C: Campus Feeder 5C (Future)

g. N6C: Campus Feeder 6C (Future)

h. N7C: Campus Feeder 7C (Future)

i. NTC: Tie breaker to Bus ND

4. North Switching Station, Bus D

a. NMD: Main breaker, Bus D

b. N1D: Campus Feeder 1D

c. N2D: Campus Feeder 2D

d. N3D: Campus Feeder 3D

e. N4D: Campus Feeder 4D

f. N5D: Campus Feeder 5D (Future)

g. N6D: Campus Feeder 6D (Future)

h. N7D: Campus Feeder 7D (Future)

i. NTD: Tie breaker to Bus NA

5. South Switching Station, Bus A (Future)

a. SMA: Main breaker, Bus A

b. S1A: Campus Feeder 1A

c. S2A: Campus Feeder 2A

d. S3A: Campus Feeder 3A

e. S4A: Campus Feeder 4A

f. S5A: Campus Feeder 5A

g. S6A: Campus Feeder 6A

h. S7A: Campus Feeder 7A

i. STA: Tie breaker to Bus SB

6. South Switching Station, Bus B (Future)
    a. SMB: Main breaker, Bus B
    b. S1B: Campus Feeder 1B
    c. S2B: Campus Feeder 2B
    d. S3B: Campus Feeder 3B
    e. S4B: Campus Feeder 4B
    f. S5B: Campus Feeder 5B
    g. S6B: Campus Feeder 6B
    h. S7B: Campus Feeder 7B
    i. STB: Tie breaker to Bus SC
7. South Switching Station, Bus C (Future)
    a. SMC: Main breaker, Bus C
    b. S1C: Campus Feeder 1C
    c. S2C: Campus Feeder 2C
    d. S3C: Campus Feeder 3C
    e. S4C: Campus Feeder 4C
    f. S5C: Campus Feeder 5C
    g. S6C: Campus Feeder 6C
    h. S7C: Campus Feeder 7C
    i. STC: Tie breaker to Bus SD
8. South Switching Station, Bus D (Future)
    a. SMD: Main breaker, Bus D
    b. S1D: Campus Feeder 1D
    c. S2D: Campus Feeder 2D
    d. S3D: Campus Feeder 3D
    e. S4D: Campus Feeder 4D
    f. S5D: Campus Feeder 5D

g. S6D: Campus Feeder 6D

h. S7D: Campus Feeder 7D

i. STD: Tie breaker to Bus SA

9. Howard Hall 15kV Switchgear

a. HNA: Main Breaker, North Switching Station, Bus A

b. HNB: Main Breaker, North Switching Station, Bus B

c. HSA: Main Breaker, South Switching Station, Bus A

d. HSB: Main Breaker, South Switching Station, Bus B

e. G1: Generator Paralleling Switchgear Feeder, Bus 1

f. B1: Bressler Research Building Substation 1 Feeder

g. B5: Bressler Research Building Substation 5 Feeder

h. HA: Howard Hall 480V Switchgear, Substation A Feeder

i. HT: Bus Tie Breaker

j. HB: Howard Hall 480V Switchgear, Substation B Feeder

k. B2: Bressler Research Building Substation 2 Feeder

l. B6: Bressler Research Building Substation 6 Feeder

m. B8: Bressler Research Building Substation 8 Feeder

n. G2: Generator Paralleling Switchgear Feeder, Bus 2

10. Howard Hall Generator Paralleling Switchgear

a. MG1: Main Breaker, HH 15kV Switchgear, Bus A

b. MG2: Main Breaker, HH 15kV Switchgear, Bus B

c. SB-G1: 1100kW Generator

d. SB-G2: 1500kW Generator

e. SB-G3: Future Generator

f. SB-G4: Future Generator

g. SB-G5: Future Generator

h. SB-G6: Future Generator

i. SB-G7: Peaking Plant Bus A

j. SB-G8: Peaking Plant Bus B

k. GT: Bus Tie Breaker

11. Peaking Plant Paralleling Switchgear

a. A-F1: Switchgear E/NG5B1 Feeder

b. A-F2: DP-1 Feeder

c. A-F3: Howard Hall Generator Paralleling Switchgear Bus 1 Feeder

d. A-F4: Future Feeder

e. B-F1: Switchgear E/NG5B1 Feeder

f. B-F2: Future Feeder

g. B-F3: Howard Hall Generator Paralleling Switchgear Bus 2 Feeder

h. B-F4: Future Feeder

i. A-G1: 2000kW Gas Generator No. 1

j. B-G2: 2000kW Gas Generator No. 2

k. B-G3: 2000kW Gas Generator No. 3

l. A-G4: Future Generator

1.4 Normal Operating conditions

1. North Switching Station Breaker

North Switching Station Switchgear		
Breaker Designation	NO	NC
NMA		X
N1A		X
N2A		X
N3A		X
N4A		X

N5A		X
N6A		X
NTA		X
Note: The distribution breakers will be Kirk-Key interlocked with the South Switching Station Distribution breakers. Only one source can supply the load at a time from the North or South Switching Station. Note: Breakers in SWGR NB, NC, and ND have the same naming format but end with their respective letter instead of A.		

2. Howard Hall Main 15KV Switchgear.

Howard Hall 15KV Switchgear		
Breaker Designation	NO	NC
HNA		X
HNB		X
HSA	X	
HSB	X	
G2		X
SPARE	X	
B5		X
B1		X
HA		X
HT(TIE)	X	
HB		X
B2		X

B6		X
B8		X
G1		X

3. Howard Hall Generator Switchgear

Howard Hall 15 KV Generator Switchgear		
Breaker Designation	NO	NC
MG1		X
SBG1	X	
FUT-SBG3	X	
FUT-SBG5	X	
SBG7		X
GT(TIE)		X
SBG2	X	
FUT-SBG4	X	
FUT-SBG6	X	
SBG8		X
MG2		X

4. 15KV Peaking Plant

Peaking Plant 15KV Switchgear		
Breaker Designation	NO	NC
A-G4 (EQUIPPED SPACE)		
A-G1	X	
A-F1		X

A-F2		X
A-F3	X	
A-F4 (EQUIPPED SPACE)		
T-1	X	
B-F4 (EQUIPPED SPACE)		
B-F3	X	
B-F2	X	
B-F1		X
B-G2	X	
B-G3	X	

1.5 NORTH SWITCHING STATION PROCEDURES

A. Loss of Single Utility Source (Loss of Source to Bus A, B, C, or D)

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on the Main Circuit Breaker CB MN(X), the Utility Failure timer in the PLC starts. When this timer expires, Main Circuit Breaker CB MN(X) Opens.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

   a. Utility Failure timer starts.

      1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

   b. Utility Failure timer expires. Send an alarm to the control system indicating loss of single source.

   c. Open Breaker MN(X).

      1) If MN(X) fails to open: Open the two tie breakers that are closed in on that bus to isolate the Bus N(X).

d. No further steps, the Bus will be fed through the ring bus and tie breakers.

4. Final Bus and Circuit Breaker Conditions:

a. MN(X): Open

b. All other Main Breakers: Closed

c. NTA, NTB, NTC, NTD: Closed

d. All feeder breakers closed

e. Generators are Offline

B. Return of Utility during Loss of Single Source Event

1. When the utility voltage and frequency return within tolerance, the Utility Stable timer in the PLC starts if the Return Control switch is in Auto. When the timer expires, the Utility Breaker will Close back in.

2. Refer to Section 1.5.A for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility is within tolerance as monitored from the Line PTs at MN(X).

a. Utility Stable timer starts.

1) If utility is lost before timer expires, system remains with MN(X) open.

b. Utility Stable timer expires.

c. Main Breaker MN(X) Closes:

1) If circuit breaker MN(X) fails to close, system remains as is.

4. Refer to Section 1.04 for final Bus and Circuit Breaker conditions.

C. Loss of Multiple Utility Sources

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on Multiple Main Circuit Breakers (MNA, MNB, MNC, or MND), the Utility Failure timer in the PLC starts. When this timer expires, the Main Circuit Breakers with loss of voltage Open.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

a. Utility Failure timer starts.

1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

b. Utility Failure timer expires. Send an alarm to the control system indicating loss of sources. The control system shall monitor the load that is on the utility buses.

1) If the load on the North Switching Station is greater than the capacity of the remaining Utility Feeders (9MVA each) then the system shall initiate a load shed sequence. The control system shall open feeder breakers in reverse priority order. Refer to Section 1.12.B.2 for breaker priority list. Initiate an alarm that N+1 redundancy has been lost. Proceed with the Sequence.

2) If the load on the North Switching Station is less than the capacity of the remaining Utility Feeders (9MVA each), send an alarm to the control system that N+1 redundancy has been lost. Proceed with the sequence.

c. Open Utility Breakers with loss of voltage.

1) If MN(X) fails to open: Open the two tie breakers that are closed in on that bus to isolate the Bus N(X).

d. No further steps, the Bus will be fed through the ring bus and tie breakers.

4. Final Bus and Circuit Breaker Conditions:

a. MN(X) (Loss of Voltage): Open

b. All other Main Breakers: Closed

c. NTA, NTB, NTC, NTD: Closed

d. All feeder breakers closed

e. Generators are Offline

D. Complete Loss of Utility (Buses A-D)

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on Multiple Main Circuit Breakers (MNA, MNB, MNC, and MND), the Utility Failure timer in the PLC starts. When this timer expires, the Main Circuit Breakers MNA, MNB, MNC, and MND Open. System Generators Start.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

   a. Utility Failure timer starts.

      1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

   b. Utility Failure timer expires. Send an alarm to the control system indicating loss of North Switching Station Power

   c. Open Utility Breakers MNA, MNB, MNC, and MND and all Non-Priority 1 Breakers on the North Switching Station. Initiate an Alarm

      1) If MN(X) fails to open: Open the two tie breakers that are closed in on that bus to isolate the Bus N(X).

   d. If Howard Hall is aligned to the North Switching Station, Proceed to Section 1.7.F – Loss of Source (X)A and (X)B (Power is Not available at Source Switching Station).

   e. If Howard Hall is aligned to the South Switching Station, initiate an alarm.

E. Return of Utility Sources (A-D)

1. Refer to Section 1.9.B – Return of Utility Source

1.6 SOUTH SWITCHING STATION PROCEDURES

A. Loss of Single Utility Source (Loss of Source to Bus A, B, C, or D)

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on the Main Circuit Breaker CB MS(X), the Utility Failure timer in the PLC starts. When this timer expires, Main Circuit Breaker CB MS(X) Opens.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

   a. Utility Failure timer starts.

      1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

   b. Utility Failure timer expires. Send an alarm to the control system indicating loss of single source.

c. Open Breaker MS(X).

1) If MS(X) fails to open: Open the two tie breakers that are closed in on that bus to isolate the Bus S(X).

d. No further steps, the Bus will be fed through the ring bus and tie breakers.

4. Final Bus and Circuit Breaker Conditions:

a. MS(X): Open

b. All other Main Breakers: Closed

c. STA, STB, STC, STD: Closed

d. All feeder breakers closed

e. Generators are Offline

B. Return of Utility during Loss of Single Source Event

1. When the utility voltage and frequency return within tolerance, the Utility Stable timer in the PLC starts if the Return Control switch is in Auto. When the timer expires, the Utility Breaker will Close back in.

2. Refer to Section 1.6.A for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility is within tolerance as monitored from the Line PTs at MS(X).

a. Utility Stable timer starts.

1) If utility is lost before timer expires, system remains with MS(X) open.

b. Utility Stable timer expires.

c. Main Breaker MS(X) Closes:

1) If circuit breaker MS(X) fails to close, system remains as is.

4. Refer to Section 1.4 for final Bus and Circuit Breaker conditions.

C. Loss of Multiple Utility Sources

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on Multiple Main Circuit Breakers (MSA, MSB, MSC, or MSD), the Utility Failure timer in the PLC starts. When this timer expires, the Main Circuit Breakers with loss of voltage Open.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

   a. Utility Failure timer starts.

      1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

   b. Utility Failure timer expires. Send an alarm to the control system indicating loss of sources. The control system shall monitor the load that is on the utility buses.

      1) If the load on the South Switching Station is greater than the capacity of the remaining Utility Feeders (9MVA each) then the system shall initiate a load shed sequence. The control system shall open feeder breakers in reverse priority order. Refer to Section 1.12.B.2 for breaker priority list. Initiate an alarm that N+1 redundancy has been lost. Proceed with the Sequence.

      2) If the load on the South Switching Station is less than the capacity of the remaining Utility Feeders (9MVA each), send an alarm to the control system that N+1 redundancy has been lost. Proceed with the sequence.

   c. Open Utility Breakers with loss of voltage.

      1) If MS(X) fails to open: Open the two tie breakers that are closed in on that bus to isolate the Bus S(X).

   d. No further steps, the Bus will be fed through the ring bus and tie breakers.

4. Final Bus and Circuit Breaker Conditions:

   a. MS(X) (Loss of Voltage): Open

   b. All other Main Breakers: Closed

   c. STA, STB, STC, STD: Closed

   d. All feeder breakers closed

   e. Generators are Offline

D. Complete Loss of Utility (Buses A-D)

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on Multiple Main Circuit Breakers (MSA, MSB, MSC,

and MSD), the Utility Failure timer in the PLC starts. When this timer expires, the Main Circuit Breakers MSA, MSB, MSC, and MSD Open. System Generators Start.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

   a. Utility Failure timer starts.

      1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

   b. Utility Failure timer expires. Send an alarm to the control system indicating loss of South Switching Station Power

   c. Open Utility Breakers MSA, MSB, MSC, and MSD and all Non-Priority 1 Breakers on the South Switching Station. Initiate an Alarm

      1) If MS(X) fails to open: Open the two tie breakers that are closed in on that bus to isolate the Bus S(X).

   d. If Howard Hall is aligned to the South Switching Station, Proceed to Section 1.7.F – Loss of Source (X)A and (X)B (Power is Not available at Source Switching Station).

   e. If Howard Hall is aligned to the North Switching Station, initiate an alarm.

E. Return of Utility Sources (A-D)

1. Refer to Section 1.9.B – Return of Utility Source

1.7 HOWARD HALL 15KV SWITCHGEAR AUTOMATIC PROCEDURES

A. Loss of Source (X)A, System on (X)A ((X) indicates N or S for North or South Switching Station)

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on CB H(X)A, the Utility Failure timer in the PLC starts. When this timer expires, the building loads transfer to CB H(X)B.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

   a. Utility Failure timer starts.

1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

b. Utility Failure timer expires.

c. Open Main Breaker H(X)A.

1) If H(X)A fails to open: Open circuit breaker H(X)B to isolate Howard Hall 15kV Switchgear. Proceed to Loss of Source (X)A and (X)B.

d. Close Tie Breaker HT.

1) If HT fails to close: Terminate Sequence. Power to downstream equipment will be restored through transfers on 480V equipment.

e. The remainder Breakers of the system shall remain as is.

4. Final Bus and Circuit Breaker Conditions:

a. H(X)A: Open

b. H(X)B: Closed

c. HT: Closed

d. All feeder breakers closed

e. Generators are Offline

B. Return of Source (X)A ((X) indicates N or S for North or South Switching Station)

1. When the utility voltage and frequency return within tolerance, the Utility Stable timer in the PLC starts if the Return Control switch is in Auto. When the timer expires, the Howard Hall 15kV Switchgear loads transfer from Source (X)B power only back to split bus Source (X)A and (X)B power. There will be no loss of power to the facility loads during the closed transition transfer.

2. Refer to Section 1.7 – A for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility is within tolerance as monitored from the Line PTs at H(X)A.

a. Utility Stable timer starts.

1) If utility is lost before timer expires, system remains source H(X)B.

b. Utility Stable timer expires.

c. Main Breaker HNA Closes:

1) If circuit breaker H(X)A fails to close, remain on H(X)B and terminate the sequence.

d. Live/Live Closed Transfer timer starts. The Closed Transfer timer will be initially set such that the total paralleled time during transfer is 100ms.

e. Live/Live Closed Transfer timer expires.

f. Tie breaker HT opens.

1) If circuit breaker HT fails to open, open circuit breaker H(X)A and initiate system alarm.

g. The facility operates on utility power with HH 15kV Switchgear energized in a split bus configuration.

4. Refer to Section 1.4 for final Bus and Circuit Breaker conditions.

C. Loss of Source (X)B ((X) indicates N or S for North or South Switching Station)

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on CB H(X)B, the Utility Failure timer in the PLC starts. When this timer expires, the building loads transfer to CB H(X)A.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

a. Utility Failure timer starts.

1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

b. Utility Failure timer expires.

c. Open Main Breaker H(X)B.

1) If H(X)B fails to open: Open circuit breaker H(X)A to isolate Howard Hall 15kV Switchgear. Proceed to Loss of Source (X)A and (X)B.

d. Close Tie Breaker HT.

1) If HT fails to close: Terminate Sequence. Power to downstream equipment will be restored through transfers on 480V equipment.

e. The remainder Breakers of the system shall remain as is.

4. Final Bus and Circuit Breaker Conditions:

a. H(X)A: Closed

b. H(X)B: Open

c. HT: Closed

d. All feeder breakers closed

e. Generators are Offline

D. Return of Source NB (X)B ((X) indicates N or S for North or South Switching Station)

1. When the utility voltage and frequency return within tolerance, the Utility Stable timer in the PLC starts if the Return Control switch is in Auto. When the timer expires, the Howard Hall 15kV Switchgear loads transfer from Source NA power only back to split bus Source (X)A and (X)B power. There will be no loss of power to the facility loads during the closed transition transfer.

2. Refer to Section 1.7 – C for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility is within tolerance as monitored from the Line PTs at H(X)B.

a. Utility Stable timer starts.

1) If utility is lost before timer expires, system remains source H(X)A.

b. Utility Stable timer expires.

c. Main Breaker H(X)B Closes:

1) If circuit breaker H(X)B fails to close, remain on H(X)A and terminate the sequence.

d. Live/Live Closed Transfer timer starts. The Closed Transfer timer will be initially set such that the total paralleled time during transfer is 100ms.

e. Live/Live Closed Transfer timer expires.

f. Tie breaker HT opens.

1) If circuit breaker HT fails to open, open circuit breaker H(X)B and initiate system alarm.

g. The facility operates on utility power with HH 15kV Switchgear energized in a split bus configuration.

4. Refer to Section 1.4 for final Bus and Circuit Breaker conditions.

E. Loss of Source NA and NB – Howard Hall on North Switching Station (Power is available at North Switching Station and South Switching Station)

1. When the utility voltage or frequency falls out of tolerance as detected by the PLC from the line PTs at HNA and HNB, the Utilities Failure timer in the PLC starts. At the same time, stable voltage is detected by the line PT's on HSA and HSB. Sequence will transfer the power source from the North to the South Switching Station.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

    a. Utility Failure timer starts.

        1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

    b. Utility Failure timer expires for both HNA source and HNB source.

    c. HNA, HNB, and HT Breakers shall open.

        1) If HNA breaker fails to open: Proceed with sequence but do not attempt to close HSA. Hardwired electrical interlocks will prevent this breaker from closing as well.

        2) If HNB breaker fails to open: Proceed with sequence but do not attempt to close HSB. Hardwired electrical interlocks will prevent this breaker from closing as well.

        3) If Tie breaker HT fails to open: Open breaker HNB and keep HSB open.

    d. Close Main Breaker HSA.

        1) If HSA fails to close, close Tie Breaker HT and proceed to next step.

    e. Close Main Breaker HSB.

        1) If HSB fails to close, close Tie Breaker HT.

4. Final Bus and Circuit Breaker Conditions:

    a. HNA: Open

    b. HNB: Open

    c. HSA: Closed

    d. HSB: Closed

    e. HT: Open

f. All feeder breakers closed

g. Generators are Offline

F. Loss of Source SA and SB – Howard Hall on South Switching Station (Power is available at North Switching Station and South Switching Station)

1. When the utility voltage or frequency falls out of tolerance as detected by the PLC from the line PTs at HSA and HSB, the Utilities Failure timer in the PLC starts. At the same time, stable voltage is detected by the line PT's on HNA and HNB. Sequence will transfer the power source from the North to the South Switching Station.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

a. Utility Failure timer starts.

1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

b. Utility Failure timer expires for both HSA source and HSB source.

c. HSA, HSB, and HT Breakers shall open.

1) If HSA breaker fails to open: Proceed with sequence but do not attempt to close HNA. Hardwired electrical interlocks will prevent this breaker from closing as well.

2) If HSB breaker fails to open: Proceed with sequence but do not attempt to close HNB. Hardwired electrical interlocks will prevent this breaker from closing as well.

3) If Tie breaker HT fails to open: Open breaker HSB and keep HNB open.

d. Close Main Breaker HNA.

1) If HNA fails to close, close Tie Breaker HT and proceed to next step.

e. Close Main Breaker HNB.

1) If HNB fails to close, close Tie Breaker HT.

4. Final Bus and Circuit Breaker Conditions:

a. HNA: Closed

b. HNB: Closed

c. HSA: Open

d. HSB: Open

e. HT: Open

f. All feeder breakers closed

g. Generators are Offline

G. Loss of Source (X)A and (X)B (Power is Not available at the Source Switching Station)

1. When the utility voltage or frequency falls out of tolerance as detected by the PLC from the line PTs at H(X)A and H(X)B, the Utilities Failure timer in the PLC starts. When the timer expires, the load shed scheme will be initiated and the campus generators will be brought online to provide power to the North Switching Station.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Source at H(X)A and H(X)B out of tolerance.

a. Utility Failure timer starts.

1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

b. Utility Failure timer expires for both Utility H(X)A and Utility H(X)B.

c. Proceed to Section 1.9.A - Loss of Voltage to Both Buses in Howard Hall 15kV Switchgear (Source Switching Station also has loss of voltage).

H. Return of Source (X)A and (X)B (System is on Generators)

a. Refer to Section 1.9.B – Return of Utility Source

1.8 HOWARD HALL 15KV SWITCHGEAR MANUAL PROCEDURES

A. Transfer from Split Bus (X)A+(X)B to (X)A only

1. The following procedure will be operator initiated. The operator shall be able to initiate the procedure by selecting this procedure from a procedures screen. When the procedure is selected a prompt shall pop-up asking the operator to confirm the

selection. If the initial conditions do not match as described below, the procedure shall not be able to be selected from the procedures list.

2. Initial Conditions:

   a. Main Breakers H(X)A and H(X)B: CLOSED.

   b. Tie Breaker HT: OPEN

   c. Generators Offline. System Receiving Normal Power through the Source Switching Station

3. Sequence:

   a. Operator Selects the Procedure from the HMI.

   b. Close Tie Breaker HT.

      1) If HT fails to Close: Cancel procedure, initiate an alarm.

   c. Open Main Breaker H(X)B

      1) If (HX)B fails to Open: Open HT and all feeder breakers on HH 15KV Switchgear Bus B. Initiate an Alarm.

4. Final Bus and Circuit Breaker Conditions

   a. H(X)A: Closed

   b. H(X)B: Open

   c. HT: Closed

   d. All Feeder Breakers Closed

   e. Generators Offline

B. Transfer from Split Bus (X)A+(X)B to (X)B only

1. The following procedure will be operator initiated. The operator shall be able to initiate the procedure by selecting this procedure from a procedures screen. When the procedure is selected a prompt shall pop-up asking the operator to confirm the selection. If the initial conditions do not match as described below, the procedure shall not be able to be selected from the procedures list.

2. Initial Conditions:

   a. Main Breakers H(X)A and H(X)B: CLOSED.

   b. Tie Breaker HT: OPEN

c. Generators Offline. System Receiving Normal Power through the Source Switching Station

3. Sequence:

a. Operator Selects the Procedure from the HMI.

b. Close Tie Breaker HT.

1) If HT fails to Close: Cancel procedure, initiate an alarm.

c. Open Main Breaker H(X)A

1) If H(X)A fails to Open: Open HT and all feeder breakers on HH 15KV Switchgear Bus A. Initiate an Alarm.

4. Final Bus and Circuit Breaker Conditions

a. H(X)A: Open

b. H(X)B: Closed

c. HT: Closed

d. All Feeder Breakers Closed

e. Generators Offline

C. Transfer from (X)A only to Split Bus (X)A+(X)B

1. The following procedure will be operator initiated. The operator shall be able to initiate the procedure by selecting this procedure from a procedures screen. When the procedure is selected a prompt shall pop-up asking the operator to confirm the selection. If the initial conditions do not match as described below, the procedure shall not be able to be selected from the procedures list.

2. Initial Conditions:

a. Main Breaker H(X)A: CLOSED

b. Main Breaker H(X)B: OPEN

c. Tie Breaker HT: CLOSED

d. Generators Offline. System Receiving Normal Power through the Source Switching Station

e. Normal Voltage and Frequency is Available at H(X)B as determined by the Line PT's.

3. Sequence:
    a. Operator Selects the Procedure from the HMI.
    b. Close Main Breaker H(X)B.
        1) If H(X)B fails to Close: Cancel procedure, initiate an alarm.
    c. Open Tie Breaker HT
        1) If HT fails to Open: Open (X)B and initiate an Alarm.
4. Final Bus and Circuit Breaker Conditions
    a. H(X)A: Closed
    b. H(X)B: Closed
    c. HT: Open
    d. All Feeder Breakers Closed
    e. Generators Offline

D. Transfer from H(X)B only to Split Bus H(X)A+H(X)B
1. The following procedure will be operator initiated. The operator shall be able to initiate the procedure by selecting this procedure from a procedures screen. When the procedure is selected a prompt shall pop-up asking the operator to confirm the selection. If the initial conditions do not match as described below, the procedure shall not be able to be selected from the procedures list.
2. Initial Conditions:
    a. Main Breaker H(X)A: OPEN
    b. Main Breaker H(X)B: CLOSED
    c. Tie Breaker HT: CLOSED
    d. Generators Offline. System Receiving Normal Power through the Source Switching Station
    e. Normal Voltage and Frequency is Available at H(X)A as determined by the Line PT's.
3. Sequence:
    a. Operator Selects the Procedure from the HMI.

b. Close Main Breaker H(X)A.

1) If H(X)A fails to Close: Cancel procedure, initiate an alarm.

c. Open Tie Breaker HT

1) If HT fails to Open: Open H(X)A and initiate an Alarm.

4. Final Bus and Circuit Breaker Conditions

a. H(X)A: Closed

b. H(X)B: Closed

c. HT: Open

d. All Feeder Breakers Closed

e. Generators Offline

E. Transfer from North SS (Split bus NA+NB) to South SS (Split bus SA+SB)

1. The following procedure will be operator initiated. The operator shall be able to initiate the procedure by selecting this procedure from a procedures screen. When the procedure is selected a prompt shall pop-up asking the operator to confirm the selection. If the initial conditions do not match as described below, the procedure shall not be able to be selected from the procedures list.

2. Initial Conditions:

a. Main Breaker HNA: CLOSED

b. Main Breaker HNB: CLOSED

c. Main Breaker HSA: OPEN

d. Main Breaker HSB: OPEN

e. Tie Breaker HT: OPEN

f. Generators Offline. System Receiving Normal Power through the Source Switching Station

g. Normal Voltage and Frequency is Available at HSA and HSB as determined by the Line PT's.

3. Sequence:

a. Operator Selects the Procedure from the HMI.

b. Generators Start and Parallel together on the HH 15KV Generator Switchgear. Refer to section 1.13.A – Run Request To All Generators (Howard Hall and Peaking Plant).

c. When generators are paralleled on the generator bus parallel the generators to the HH utilty source. Close breakers MG1 and MG2.

1) If MG1 or MG2 fails to close: Initiate an alarm and abandon the procedure.

d. Open Main Breakers HNA and HNB. Howard Hall is now being fed by the generators.

1) If HNA or HNB fails to Open: Initiate an alarm and abandon the procedure.

e. Generator controls shall begin to synchronize with South Switching Station utilizing line PT's HSA and HSB.

f. When generator control system has paralleled with HSA and HSB sources, close HSA and HSB breakers.

1) If HSA or HSB fails to close: Close HT and continue with the procedure.

g. Begin unload of generators.

h. When generators have unloaded, Open Generator Breakers SB-G1 through SB-G7, A-G1, B-G1, B-G3, A-F3 and B-F3.

1) If any generator breakers on the HH 15kV Generator Switchgear fail to open: initiate an alarm and isolate that bus by opening the MG1 or MG2 and the tie breaker.

2) If any generator breakers on the Peaking Plant Switchgear fail to open: initiate an alarm and isolate that bus by opening breakers A-F1 or B-F1 and the T-1 tie breaker.

3) If A-F3 or B-F3 fail to open: Initiate an alarm and open the corresponding breaker in the Howard Hall 15kV Generator Switchgear, SB-G7 or SB-G8.

4. Final Bus and Circuit Breaker Conditions

a. HNA: Open

b. HNB: Open

c. HSA: Closed

d. HSB: Closed

e. HT: Open

f. All Feeder Breakers Closed

g. Generators Offline

F. Transfer from South SS (Split bus SA+SB) to North SS (Split bus NA+NB)

1. The following procedure will be operator initiated. The operator shall be able to initiate the procedure by selecting this procedure from a procedures screen. When the procedure is selected a prompt shall pop-up asking the operator to confirm the selection. If the initial conditions do not match as described below, the procedure shall not be able to be selected from the procedures list.

2. Initial Conditions:

a. Main Breaker HNA: OPEN

b. Main Breaker HNB: OPEN

c. Main Breaker HSA: CLOSED

d. Main Breaker HSB: CLOSED

e. Tie Breaker HT: OPEN

f. Generators Offline. System Receiving Normal Power through the Source Switching Station

g. Normal Voltage and Frequency is Available at HNA and HNB as determined by the Line PT's.

3. Sequence:

a. Operator Selects the Procedure from the HMI.

b. Generators Start and Parallel together on the HH 15KV Generator Switchgear. Refer to section 1.13.A – Run Request To All Generators (Howard Hall and Peaking Plant).

c. When generators are paralleled on the generator bus parallel the generators to the HH utilty source. Close breakers MG1 and MG2.

1) If MG1 or MG2 fails to close: Initiate an alarm and abandon the procedure.

d. Open Main Breakers HSA and HSB. Howard Hall is now being fed by the generators.

1) If HSA or HSB fails to Open: Initiate an alarm and abandon the procedure.

e. Generator controls shall begin to synchronize with South Switching Station utilizing line PT's HNA and HNB.

f. When generator control system has paralleled with HNA and HNB sources, close HNA and HNB breakers.

1) If HNA or HNB fails to close: Close HT and continue with the procedure.

g. Begin unload of generators.

h. When generators have unloaded, Open Generator Breakers SB-G1 through SB-G7, A-G1, B-G1, B-G3, A-F3 and B-F3.

1) If any generator breakers on the HH 15kV Generator Switchgear fail to open: initiate an alarm and isolate that bus by opening the MG1 or MG2 and the tie breaker.

2) If any generator breakers on the Peaking Plant Switchgear fail to open: initiate an alarm and isolate that bus by opening breakers A-F1 or B-F1 and the T-1 tie breaker.

3) If A-F3 or B-F3 fail to open: Initiate an alarm and open the corresponding breaker in the Howard Hall 15kV Generator Switchgear, SB-G7 or SB-G8.

4. Final Bus and Circuit Breaker Conditions

a. HNA: Closed

b. HNB: Closed

c. HSA: Open

d. HSB: Open

e. HT: Open

f. All Feeder Breakers Closed

g. Generators Offline

1.9 HOWARD HALL GENERATOR PARALLELING SWITCHGEAR AND PEAKING PLANT GENERATOR SWITCHGEAR

A. Loss of Voltage to Both Buses in Howard Hall 15kV Switchgear (Source Switching Station also has loss of voltage)

1. When the utility voltage or frequency falls out of tolerance as detected by the PLC from the line PTs in the Howard hall 15kV Switchgear, the Utilities Failure timer in the PLC starts. The building loads transfer to standby generator power.

2. Refer to Section 1.04 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

   a. Utility Failure timer starts.

      1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

   b. Utility Failure timer expires for both the A Bus and B Bus.

   c. Open Howard Hall 15kV Main breakers HNA, HNB, HSA, and HSB, and all non-priority 1 Breakers at Howard Hall, BRB, and Source Switching Station.

      1) If non-priority 1 Breaker in Source Switching Station fails to open, open Howard Hall 15kV Main Breakers (H(X)A and H(X)B).

      2) If non-priority 1 breaker in Howard Hall 15kV Switchgear fails to open, isolate that bus by opening the 15kV Main Breakers on that bus HNX and HSX, the tie HT, and the Generator Breaker on that bus, GX.

      3) If non-priority 1 Breaker in Howard Hall or Bressler Research Building 480V Switchgear fails to open, then isolate that bus by opening the Main 480V breaker and Tie Breaker.

   d. Open Howard Hall Generator Switchgear Breakers MG1 and MG2.

      1) If MG1 or MG2 fails to open: Initiate an alarm and open corresponding breaker G1 or G2. Continue with Procedure.

   e. Initiate start signal for all standby engines (HH Roof 1500kW, HH Roof 1100kW, and Peaking Plant Gas Generators). Refer to Section 1.13.A – Run Request To All Generators (Howard Hall and Peaking Plant) for Generator Startup Sequence.

1) If a generator breaker fails to close, the still operable circuit breakers shall close once the associated engine reaches rated voltage and frequency. The remaining engine shall enter cooldown mode and shutdown.

2) If a generator fails to reach rated voltage and frequency, the sequence shall be aborted and a system alarm initiated.

f. When both Howard Hall generators have paralleled, close breakers MG1 and MG2.

1) If MG1 or MG2 breakers fail to close: Initiate an alarm and continue with procedure.

g. Close Howard Hall 15kV breakers in order of priority.

1) If any breaker fails to close, alarm and proceed with sequence.

h. When HSF3 and Howard Hall 15kV switchgear re-energization sequence has been completed and HSF3 and Howard Hall generators have been paralleled, Close Howard Hall 15kV Main Breakers HXA and HXB to energize the Source Switching Station.

1) If HXA or HXB fails to close, alarm and proceed with sequence.

i. Switchgear control system shall analyze the available generator capacity and existing system load. The Control system shall close in feeder breakers on the Source Switching Station according to the priority list and available generator capacity.

4. Final Bus and Circuit Breaker Conditions:

a. HXA (to Source Switching Station): Closed

b. HXB (to Source Switching Station): Closed

c. HT: Closed

d. XMA, XMB, XMC, XMD (Source Switching Station): Open

e. Source Switching Station: Load shed mode

f. Generators are Online. Howard Hall and Peaking Plant, paralleled.

B. Return of Utility Source

1. When the utility voltage and frequency return within tolerance for three or more utility breakers from the Source Switching Station, the Utility Stable timer in the

PLC starts if the Return Control switch is in Auto. When the timer expires, the generators will synchronize to the Utility at the Source Switching Station and loads will be transferred from generator to utility power. There will be a loss of power to the facility loads during the open transition transfer.

2. Refer to Section 1.9 – A for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility is within tolerance as monitored from the Line PTs at the Source Switching Station for three or more Utility Breakers.

   a. Utility Stable timer starts (factory set to 10 minutes, adjustable).

      1) If utility is lost before timer expires, system remains on generators.

   b. Utility Stable timer expires.

   c. Generator controls shall begin to synchronize with the Source Switching Station by utilizing the Line PT's at MXA, MXB, MXC, or MXD.

   d. When the generator control system has paralleled the generators with the utility source, close Main Breaker XMA in the Source Switching Station.

      1) If circuit breaker XMA fails to close, initiate system alarm and proceed with sequence.

   e. Main breaker XMB in the Source Switching Station closes.

      1) If circuit breaker XMB fails to close, initiate system alarm and proceed with sequence.

   f. Main breaker XMC in the Source Switching Station closes.

      1) If circuit breaker XMC fails to close, initiate system alarm and proceed with sequence.

   g. Main breaker XMD in the Source Switching Station closes.

      1) If circuit breaker XMD fails to close, initiate system alarm and proceed with sequence.

   h. When two Utility Breakers have closed, begin soft unloading the generators.

   i. When generators have unloaded, Open Generator Breakers SB-G1 through SB-G7, A-G1, B-G2, B-G3, A-F3 and B-F3.

      1) If any generator breakers on the HH 15kV Generator Switchgear fail to open: initiate an alarm and isolate that bus by opening the MG1 or MG2 and the tie breaker.

2) If any generator breakers on the Peaking Plant Switchgear fail to open: initiate an alarm and isolate that bus by opening breakers A-F1 or B-F1 and the T-1 tie breaker.

3) If A-F3 or B-F3 fail to open: Initiate an alarm and open the corresponding breaker in the Howard Hall 15kV Generator Switchgear, SB-G7 or SB-G8.

j. All feeder breakers close in priority order.

1) If any feeder breaker fails to close, initiate an alarm and proceed with the sequence.

k. The facility operates on utility power.

4. Refer to Section 1.4 for final Bus and Circuit Breaker conditions.

C. Loss of Voltage to HSF3 (Only at HSF3)

1. When the utility voltage or frequency falls out of tolerance as detected by the existing HSF3 control system, a generator start signal will be transferred to the new Control System. The new control system shall detect stable voltage at the North and South Switching Station, meaning that HSF3 has lost power. HSF3 will have power restored by the Peaking Plant Generators.

2. Refer to Section 1.04 for initial Bus and Circuit Breaker conditions.

3. Sequence: Generator start signal received from HSF3 control system.

a. Stable voltage is detected on the North and South Switching Station Buses.

b. Open Breakers A-F1 and B-F1.

1) If A-F1 or B-F1 fails to Open: Open tie breaker T-1 and begin shutdown sequence of the generators on that bus. Initiate an alarm.

c. Initiate startup of Peaking Plant Generators Once the first engine has reached rated voltage and frequency, close the associated breaker. The remaining engines shall synchronize with the online engine and the associated breaker close.

1) If a generator breaker fails to close, the still operable circuit breakers shall close once the associated engine reaches rated voltage and frequency. The remaining engine shall enter cooldown mode and shutdown.

2) If a generator fails to reach rated voltage and frequency, the sequence shall be aborted and a system alarm initiated.

d. Close Breakers A-F1 and B-F1.

1) If A-F1 or B-F1 fails to close, initiate an alarm and continue with the procedure.

e. HSF3 is fed from the peaking plant generators. HSF3 existing control system restores load to HSF3.

4. Final Bus and Circuit Breaker Conditions:

a. A-F1: Closed

b. B-F1: Closed

c. A-F3: Open

d. B-F3: Open

e. T-1: Closed

f. A-G1: Closed

g. B-G2: Closed

h. B-G3: Closed

D. Return of Voltage to HSF3 (Only HSF3 without utility power)

1. When the utility voltage and frequency return to stable as detected by the GE modified HSF3 control system, the HSF3 GE Automation System shall send generator frequency control signals to the generator control system to begin synchronization with utility. The HSF3 GE Automation System shall continue to modulate the generators frequency until the HSF3 GE Automation System synchronization check is satisfied. HSF3 shall initiate a closed-transition back to utility and open the breakers to the Peaking Plant. Upon verification that the closed-transition was successful by the HSF3 control system, a generator shutdown signal is sent to the generator control system. The generator control system will begin shutdown of the generators and open the generator breakers.

2. Refer to Section 1.9.C for initial Bus and Circuit Breaker conditions.

3. Sequence: Generator shutdown signal received from HSF3 control system.

a. Generator Control system begins shutdown procedures for generators.

b. Open Breakers A-G1, B-G2, and B-G3.

1) If A-G1, B-G2, or B-G3 fails to Open: Open tie breaker T-1 and corresponding main breaker A-F1 or B-F1 to isolate that bus. Initiate an alarm and continue with procedure.

4. Refer to Section 1.4 for final Bus and Circuit Breaker conditions.

E. No Load Testing

1. Operator Selects No Load Test from the HMI

a. All available generators are started.

b. The system remains in No Load Test Mode until Operator ends the test mode from the HMI.

c. When the operator ends the No Load Test Mode from the HMI, the generators are allowed to run for their programmed cool down period.

d. The system returns to Auto/Standby mode.

F. Utility Fail Test Mode

1. Operator Selects Utility Fail Test Mode from the HMI

a. The Source Switching Station Fail Test Switch is placed in the ON position.

b. Voltage sensing at the 4 utility BG&E service entrance breakers protective relay are opened, which simulates a loss of utility.

c. The system enters into a Sequence for Complete Loss of Utility (Section 1.5.D or 1.6.D).

d. Exit from Source Switching Station Fail Test Mode

e. The Source Switching Station Fail Test Switch is placed in the OFF position.

f. Voltage sensing at the 4 utility BG&E service entrance protective relays is restored, which simulates the return of utility power.

g. The system exits from a Source Switching Station Failure as described in Section 1.9.B – Return of Utility Source.

G. Live Load Test Mode

a. Parallel Gens and do closed transition.

b. Load gens using Howard Hall

c. Turn on/off gens as needed

d. Transfer back to utility

e. Shutdown Generators

H. Load Management Demand Reponse

1. The generator control system shall be capable of receiving demand response signal from the BAS system to start individual generators for demand response purposes. The BAS system will send a signal to the switchgear control system to enter demand response mode and start the generators. Under this project, the contractor shall provide the hardwired points from the BAS system to start the generators. A future project will incorporate the signals into the BAS system. Refer to specification 262313, 2.18.C for details.

1.10 HOWARD HALL AND BRESSLER RESEARCH BUILDING 480V SWITCHGEAR AUTOMATIC PROCEDURES

A. Loss of Voltage to Bus A Line Side

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on the Bus A Main Breaker, the Utility Failure timer in the PLC starts. When this timer expires, the building loads transfer to Bus B.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

a. Utility Failure timer starts.

1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

b. Utility Failure timer expires.

c. Open Main Breaker on Bus A.

1) If Main Breaker fails to open: Open the 15kV Breaker HA and initiate an alarm. Proceed with the sequence.

d. Close Tie Breaker.

1) If Tie Breaker fails to close: Terminate Sequence. Initiate an alarm.

e. The remainder Breakers of the system shall remain as is.

4. Final Bus and Circuit Breaker Conditions:

a. Bus A Main Breaker: Open

b. Bus B Main Breaker: Closed

c. Tie Breaker: Closed

d. All feeder breakers closed

e. Generators are Offline

B. Return of Voltage to Bus A Line Side of Main Breaker

1. When the utility voltage and frequency return within tolerance, the Utility Stable timer in the PLC starts. When the timer expires, the Howard Hall 480V Switchgear initiates a closed transfer from Bus B back to split bus with Source A and B. There will be no loss of power to the facility loads during the closed transition transfer.

2. Refer to Section 1.10.A for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility is within tolerance as monitored from the line side of the Main Breaker.

a. Utility Stable timer starts.

1) If utility is lost before timer expires, system remains on Bus B.

b. Utility Stable timer expires.

c. Main Breaker on Bus A Closes:

1) If Bus A Main Breaker fails to close, remain on Bus B Main Breaker and terminate the sequence. Initiate an alarm.

d. Live/Live Closed Transfer timer starts. The Closed Transfer timer will be initially set such that the total paralleled time during transfer is 100ms.

e. Live/Live Closed Transfer timer expires.

f. Tie breaker opens.

1) If tie circuit breaker fails to open, open Bus A Main circuit breaker and initiate system alarm.

g. The facility operates on utility power with HH 480V Switchgear energized in a split bus configuration.

4. Refer to Section 1.4 for final Bus and Circuit Breaker conditions.

C. Loss of Voltage to Bus B Line Side

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on the Bus B Main Breaker, the Utility Failure timer in the PLC starts. When this timer expires, the building loads transfer to Bus A.
2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.
3. Sequence: Utility out of tolerance.
    a. Utility Failure timer starts.
        1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.
    b. Utility Failure timer expires.
    c. Open Main Breaker on Bus B.
        1) If Main Breaker fails to open: Open the 15kV Breaker HB and initiate an alarm. Proceed with the sequence.
    d. Close Tie Breaker.
        1) If Tie Breaker fails to close: Terminate Sequence. Initiate an alarm.
    e. The remainder Breakers of the system shall remain as is.
4. Final Bus and Circuit Breaker Conditions:
    a. Bus A Main Breaker: Closed
    b. Bus B Main Breaker: Open
    c. Tie Breaker: Closed
    d. All feeder breakers closed
    e. Generators are Offline

D. Return of Voltage to Bus B Line Side of Main Breaker

1. When the utility voltage and frequency return within tolerance, the Utility Stable timer in the PLC starts. When the timer expires, the Howard Hall 480V Switchgear initiates a closed transfer from Bus A back to split bus with Source A and B. There will be no loss of power to the facility loads during the closed transition transfer.

2. Refer to Section 1.10 – C for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility is within tolerance as monitored from the Line side of the Main Breaker.

   a. Utility Stable timer starts.

      1) If utility is lost before timer expires, system remains on Bus A.

   b. Utility Stable timer expires.

   c. Main Breaker on Bus B Closes:

      1) If Bus B Main Breaker fails to close, remain on Bus A Main Breaker and terminate the sequence. Initiate an alarm.

   d. Live/Live Closed Transfer timer starts. The Closed Transfer timer will be initially set such that the total paralleled time during transfer is 100ms.

   e. Live/Live Closed Transfer timer expires.

   f. Tie breaker opens.

      1) If tie circuit breaker fails to open, open Bus B Main circuit breaker and initiate system alarm.

   g. The facility operates on utility power with HH 480V Switchgear energized in a split bus configuration.

      1) Refer to Section 1.4 for final Bus and Circuit Breaker conditions.

E. Loss of Voltage to Bus A and B Line Side of Main Breaker

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on the Bus A Main Breaker and Bus B Main Breaker, the Utility Failure timer in the PLC starts. The feeder breakers open and the system waits to be restored by generator power.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

   a. Utility Failure timer starts.

      1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

   b. Utility Failure timer expires.

c. Open non-priority 1 breakers. The system will be restored according to section 1.9.A.

1.11 HOWARD HALL AND BRESSLER RESEARCH BUILDING 480V SWITCHGEAR MANUALLY INITIATED PROCEDURES

A. Transfer from Split Bus Main A + Main B to Main A Only

1. The following procedure will be operator initiated. The operator shall be able to initiate the procedure by selecting this procedure from a procedures screen. When the procedure is selected a prompt shall pop-up asking the operator to confirm the selection. If the initial conditions do not match as described below, the procedure shall not be able to be selected from the procedures list.

2. Initial Conditions:

   a. Main Breakers Main A and Main B: CLOSED.

   b. Tie Breaker: OPEN

3. Sequence:

   a. Operator Selects the Procedure from the HMI.

   b. Close Tie Breaker.

      1) If Tie Breaker fails to Close: Cancel procedure, initiate an alarm.

   c. Open Main Breaker B

      1) If Main Breaker B fails to Open: Open Tie Breaker and initiate an Alarm.

4. Final Bus and Circuit Breaker Conditions

   a. Main Breaker A: Closed

   b. Main Breaker B: Open

   c. Tie Breaker: Closed

B. Transfer from Split Bus Main A + Main B to Main B Only

1. The following procedure will be operator initiated. The operator shall be able to initiate the procedure by selecting this procedure from a procedures screen. When the procedure is selected a prompt shall pop-up asking the operator to confirm the

selection. If the initial conditions do not match as described below, the procedure shall not be able to be selected from the procedures list.

2. Initial Conditions:
   a. Main Breakers Main A and Main B: CLOSED.
   b. Tie Breaker: OPEN
3. Sequence:
   a. Operator Selects the Procedure from the HMI.
   b. Close Tie Breaker.
      1) If Tie Breaker fails to Close: Cancel procedure, initiate an alarm.
   c. Open Main Breaker A
      1) If Main Breaker A fails to Open: Open Tie Breaker and initiate an Alarm.
4. Final Bus and Circuit Breaker Conditions
   a. Main Breaker A: Open
   b. Main Breaker B: Closed
   c. Tie Breaker: Closed

C. Transfer from Main A only to Split Bus Main A + Main B

1. The following procedure will be operator initiated. The operator shall be able to initiate the procedure by selecting this procedure from a procedures screen. When the procedure is selected a prompt shall pop-up asking the operator to confirm the selection. If the initial conditions do not match as described below, the procedure shall not be able to be selected from the procedures list.
2. Initial Conditions:
   a. Main Breaker Main Breaker A: CLOSED
   b. Main Breaker Main Breaker B: OPEN
   c. Tie Breaker: CLOSED
   d. Normal Voltage and Frequency is Available at Line Side of Main B Breaker.
3. Sequence:

a. Operator Selects the Procedure from the HMI.

b. Close Main Breaker B.

1) If Main Breaker B fails to Close: Cancel procedure, initiate an alarm.

c. Open Tie Breaker

1) If Tie Breaker fails to Open: Open Main Breaker B and initiate an Alarm.

4. Final Bus and Circuit Breaker Conditions

a. Main Breaker A: Closed

b. Main Breaker B: Closed

c. Tie Breaker: Open

D. Transfer from Main B only to Split Bus Main A + Main B

1. The following procedure will be operator initiated. The operator shall be able to initiate the procedure by selecting this procedure from a procedures screen. When the procedure is selected a prompt shall pop-up asking the operator to confirm the selection. If the initial conditions do not match as described below, the procedure shall not be able to be selected from the procedures list.

2. Initial Conditions:

a. Main Breaker Main Breaker A: OPEN

b. Main Breaker Main Breaker B: CLOSED

c. Tie Breaker: CLOSED

d. Normal Voltage and Frequency is Available at Line Side of Main A Breaker.

3. Sequence:

a. Operator Selects the Procedure from the HMI.

b. Close Main Breaker A.

1) If Main Breaker A fails to Close: Cancel procedure, initiate an alarm.

c. Open Tie Breaker

1) If Tie Breaker fails to Open: Open Main Breaker A and initiate an Alarm.

4. Final Bus and Circuit Breaker Conditions

   a. Main Breaker A: Closed

   b. Main Breaker B: Closed

   c. Tie Breaker: Open

1.12 GENERATOR START PROCEDURES

A. Run Request To All Generators (Howard Hall and Peaking Plant)

1. The Generator Control System Receives a Run Request to All Generators.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Generator Run Request is Received for All Generators

   (NOTE: *The individual life safety generators supporting the individual buildings upon loss of power will receive a start signal from the associated ATS. The ATS for these Life Safety systems shall be inhibited from retransferring to the normal side while the generator plant is supporting the loads.*)

   a. The first generator up to rated voltage and frequency is closed to the HH 15KV Generator Switchgear load bus. The automation dead bus logic will prevent 2 source breakers attempting to close onto the bus simultaneously.

   b. The remaining HH 15KV generators are synchronized and paralleled to the HH 15KV Generator bus as they reach rated voltage and frequency. The Peaking Plant will concurrently start and synchronize its engine generators to the 15KV Peaking Plant load bus. Upon synchronizing the Peaking Plant generators to the Peaking Plant load bus, HSFIII loads shall be added to the Peaking Plant load bus. After all generators' loads are on the load bus (factory set delay of 30 seconds to allow all loads to be added on load bus) or the expiration of the adjustable fail to synchronizing timer (factory set at 2 minutes after the load addition delay), the Peaking Plant will synchronize to the HH 15KV Generator Switchgear load bus and close the priority paralleling breaker A-F3 in the Peaking Plant Paralleling Switchgear.

      1) If A-F3 fails to close: Initiate an Alarm and continue with procedure.

   c. Close Breaker A-F4.

      1) If A-F4 fails to close: Initiate an Alarm and continue with procedure.

d. Return to Initiating Sequence.

B. Run Request To Howard Hall Generators

1. The Generator Control System Receives a Run Request to the Howard Hall Generators Only.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Generator Run Request is Received for Howard Hall Generators

(NOTE: *The individual life safety generators supporting the individual buildings upon loss of power will receive a start signal from the associated ATS. The ATS for these Life Safety systems shall be inhibited from retransferring to the normal side while the generator plant is supporting the loads.*)

a. The first generator up to rated voltage and frequency is closed to the HH 15KV Generator Switchgear load bus. The automation dead bus logic will prevent 2 source breakers attempting to close onto the bus simultaneously.

b. The remaining HH 15KV generators are synchronized and paralleled to the HH 15KV Generator bus as they reach rated voltage and frequency.

c. Return to Initiating Sequence.

1.13 FEEDER BREAKER PRIORITY LIST

A. The Building and Breaker Priority List Shall be User Adjustable in the Field from the HMI screen.

B. Feeder Breaker Priority List

1. Priority 1 Feeder Breakers

1) North Switching Station

a) N3C: Campus Feeder 3C

b) N3D: Campus Feeder 3D

c) NTA: Tie Breaker to Bus B

d) NTB: Tie Breaker to Bus C

e) NTC: Tie Breaker to Bus D

f) NTD: Tie Breaker to Bus A

2) South Switching Station

a) S3C: Campus Feeder 3C

b) S3D: Campus Feeder 3D

c) STA: Tie Breaker to Bus B

d) STB: Tie Breaker to Bus C

e) STC: Tie Breaker to Bus D

f) STD: Tie Breaker to Bus A

3) Howard Hall 15kV Switchgear

a) G1 Generator Paralleling Switchgear Feeder, Bus 1

b) G2 Generator Paralleling Switchgear Feeder, Bus 2

c) B1: BRB Substation 1 Feeder

d) HA: HH Substation A Feeder

e) HB: HH Substation B Feeder

f) B2: BRB Substation 2 Feeder

g) B5: BRB Substation 5 Feeder

h) B6: BRB Substation 6 Feeder

4) Howard Hall Generator Switchgear

a) SB-G7: Peaking Plant Bus A

b) SB-G8: Peaking Plant Bus B

c) GT: Bus Tie Breaker

5) Peaking Plant Paralleling Switchgear

a) T-1: Bus Tie Breaker

b) A-F2

6) Howard Hall 480V Switchgear

a) Bus A and Bus B: Fire Pump Controller ATS Breakers.

b) Bus A and Bus B: ATS-MECH Breakers.

c) Bus A and Bus B: ATS-EQ Breakers

7) Bressler Research Building 480V Switchgear

a) Bus A and Bus B: Fire Pump Controller ATS Breakers

b) Bus B: ATS-EQ4 Breaker

c) Bus A: ATS-EQ8 Breaker

2. Remaining Breaker Priorities Table

Breaker Name	**Load**	**Priority Number**
HH 480V – MCC-3	MCC-3	2
HH 480V – MCC-SB	MCC-SB	3
HH 480V – RP2W	RP2W	4
HH 480V – LP3W	LP3W	5
HH 480V – NHDP	NHDP	6
HH 480V – MCC-ERE	MCC-ERE	7
HH 480V – Panel DP	Panel DP	8
HH 480V – Panel A	Panel A	9
HH 480V – 1H1	1H1	10
HH 480V – HH DP1	Switchboard HH DP1	11

BRB 480V – BRB DP1	Switchboard BRB DP1	12
BRB 480V – TR-3I	Transformer 3I	13
BRB 480V – MCC BK	MCC BK	14
BRB 480V – TR 3J	Transformer 3J	15
BRB 480V – TR 6J	Transformer 6J	16
BRB 480V – MCC BL	MCC BL	17
BRB 480V – BRB DP2	Switchboard BRB DP2	18
BRB 480V – ATS 1G	ATS-1G	19
N1A/S1A	Campus Feeder 1A	20
N1B/N1B	Campus Feeder 1B	21
N4C/S4C	Campus Feeder 4C	22
N4D/S4D	Campus Feeder 4D	23
N5A/S5A	Campus Feeder 5A	24
N5B/N5B	Campus Feeder 5B	25
HH 15KV - B8	BRB Substation 8	26

N2A/S2A	Campus Feeder 2A	27
N2B/N2B	Campus Feeder 2B	28
N3A/S3A	Campus Feeder 3A	29
N3B/N3B	Campus Feeder 3B	30
N4A/S2A	Campus Feeder 4A	31
N4B/N2B	Campus Feeder 4B	32
N6A/S6A	Campus Feeder 6A	33
N6B/N6B	Campus Feeder 6B	34
N1C/S1C	Campus Feeder 1C	35
N1D/S1D	Campus Feeder 1D	36
N2C/S2C	Campus Feeder 2C	37
N2D/S2D	Campus Feeder 2D	38

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 261302

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Qualification Data: For testing agency.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

Engineer: Retain paragraph A with subparagraph if Contractor chooses Agency or retain paragraph B.

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

C. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

1.7 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. ACME Electric Corporation; Power Distribution Products Division.
2. Challenger Electrical Equipment Corp.; a division of Eaton Corp.
3. Eaton Electrical Inc.; Cutler-Hammer Products.
4. Sola/Hevi-Duty.
5. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Enclosure: Ventilated, NEMA 250, Type 4X, stainless steel.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: ANSI 49 gray.

F. Taps for Transformers 7.5 to 24 kVA: One (1) 5 % tap above and one (1) 5 % tap below normal full capacity.

G. Taps for Transformers 25 kVA and Larger: Two (2) 2.5 % taps above and two (2) 2.5 % taps below normal full capacity.

H. Insulation Class: 220^0C, UL-component-recognized insulation system with a maximum of 115^0C rise above 40^0C ambient temperature.

I. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with NEMA TP 1, Class 1 and DOE 2016 efficiency levels.
2. Tested according to NEMA TP 2.

J. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.
3. Shield Effectiveness:

a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

K. Wall Brackets: Manufacturer's standard brackets.

L. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

M. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:

1. 9 kVA and Less: 37 dBA.
2. 30 to 50 kVA: 42 dBA.
3. 51 to 150 kVA: 47 dBA.
4. 151 to 300 kVA: 52 dBA.

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 3 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 % and not being lower than nameplate voltage minus 3% at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 262313 – SWITCHGEAR CONTROLS AND AUTOMATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Monitoring and control systems for paralleling standby generators on an isolated bus, closed transition transfers to and from the utility source and for distributing electrical power.

B. The power system integrator shall be responsible for the full automated functionality of the electrical distribution system in its entirety inclusive of switchgear, substations generators and all required controls and auxiliaries.

C. Provide as part of this bid Factory Witness Testing – Include all expenses (travel, hotel, meals) for up to four people to attend the factory test as is defined by this specification.

D. Related Requirements:
1. Section 230900 “Building Automation Systems”
2. Section 260800 “Commissioning Electrical Systems”
3. Section 260913 "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
4. Section 263213 "Engine Generators" for individual generator protection and controllers.
5. Section 261300 “Medium Voltage 15KV Switchgear”
6. Section 261305 “Sequence of Operation for Electrical Equipment”
7. Section 261116 “Secondary Unit Substations”

1.3 DEFINITIONS

A. ATS: Acceptance Testing Specification.

B. DDC: Direct digital control.

C. EPS: Engine Paralleling System

D. Legally Required: As used in this Section, it shall have the same meaning as used in NFPA 70.

E. FTW: Factory Witness Test

F. NETA: International Electrical Testing Association

1.4 SUBMITTALS

A. Compliance statement as described under the Quality Assurance section of this Specification.

B. Product Data: For each type of switchgear controls and related equipment, include the following:
   1. Rated capacities, operating characteristics, furnished specialties, and accessories.
   2. Control network topology, control cabinets and cubicle elevations and protective relay system philosophy with accompanying diagrams.

C. Product Data: Include the following:

   1. Include technical data on features, performance, electrical characteristics, ratings, and finishes for programmable logic controllers, instrumentation, control devices, monitoring devices, SCADA interface devices, and display components.
   2. Include rated capacities, operating characteristics, furnished accessories, factory settings, for individual protective relays.

D. Shop Drawings: For each type of paralleling medium voltage switchgear.
   1. Include dimensioned plans, elevations, sections, details, shipping sections, weights of each assembled section, and required clearances and service space around equipment.
   2. Include tabulation of installed devices with features and ratings.
   3. Include enclosure types and details.
   4. Detail locations for anchor bolts and leveling channels.
   5. Include point-to-point schematic control, monitoring, and alarm wiring diagrams showing internal component terminal numbers.
   6. Include point-to point schematic control, monitoring, and alarm wiring diagrams for external components indicating terminal numbers for the following:

      a. Engine generators.
      b. Other load-control devices.
      c. SCADA remote terminal unit.

E. Sequence of Operation: Description of sequence of operation for paralleling controls in automatic, manual, system test, and load management modes. Sequence to comply with the detailed Sequence of Operations.
   1. Include factory testing plan for control system.

F. Bidders will provide a Compliance Review of the Specifications and Addenda (if any). The Compliance Review shall be a paragraph-by-paragraph review of the Specifications with the following information, “C”, “D” or “E” marked in the margin of the original Specifications and any subsequent Addenda.
   1. “C”: Comply with no exceptions.
   2. “D”: Comply with deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.
   3. “E”: Exception, do not comply. For each and every exception, provide a numbered foot-note with reasons and possible alternatives.

   Unless a deviation or exception is specifically noted in the Compliance Review, it is assumed that the Bidder is in complete compliance with the plans and Specifications. Deviations or exceptions taken in cover letters, subsidiary documents, by omission or by contradiction do not release the Bidder from being in complete compliance, unless the exception or deviation has been specifically noted in the Compliance Review. The Bidder may submit the latest state-of-the-art components in lieu of specified items for review and approval. All deviations from the Specifications must be approved by the Architect/Engineer.

G. Source quality-control reports.

H. Field quality-control reports.

I. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For paralleling switchgear and components to include in emergency, operation, and maintenance manuals.

   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

      a. Manufacturer's written instructions for sequence of operation.
      b. Manufacturer's system checklists, maintenance schedule, and maintenance log sheets complying with NFPA 110.
      c. Copy of any Annotated PLC code and any required cables, software or special hardware required for downloading the installed PLC program from the owners PC.
      d. Operating instructions laminated and mounted adjacent to Master Control Panel location.
      e. Training plan including PLC program download into the resident controller(s).
      f. Electronic and print versions of PLC program per section 1.6D.

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. Control Power Fuses: Six of each type and rating used. Include spares for the following:

a. Potential transformers.
b. Control power circuits.

2. Indicating Lights: Six of each type installed.
3. One HMI screen of each type installed in the system.
4. One PLC of each type installed in the paralleling control system.
5. One digital I/O card and one analog card of each type used in the control system.

B. Maintenance Tools: Furnish tools and miscellaneous items required for paralleling switchgear test, inspection, maintenance, and operation. Include the following:
1. A laptop with the final as built control software inclusive of PLC and HMI software to trouble shoot and repair the control system. The code shall be annotated and a print version provided as well as electronic version to the OWNER.
2. Complete as built drawings in PDF format loaded on the laptop with a spare CD provided to the OWNER.

1.7 QUALITY ASSURANCE

A. Compliance Statement: The equipment manufacturer shall include a Compliance Statement, at the time of Bid, listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Contractor shall engage an independent third party testing agency field supervisor: Currently certified by NETA to supervise on-site testing and commissioning.

2. The power system integrator shall provide startup and commissioning test scripts for review by the engineer and the testing agency. Startup and test documents shall be supplied 12 weeks after release for manufacturer of the product.

C. System Integration

1. The power system integrator shall provide the following:

a. Review of the major electrical equipment submittals including generators, switchgear, and secondary unit substations, to verify that all requirements needed for integration with the switchgear control system are met. The submittals will be provided to the switchgear integrator and comments shall be provided within 2 weeks to the Engineer.
b. A quotation for manufacturers' products that meet the engineer's specification and the full intent of the project. The power system offering shall be fully compliant with the project specifications and represent the best scope offering and value to the owner.
c. Assist in the development of the Method of Procedure (MOP) documents for the integration of the new system. The system integrator shall attend any meetings as required by the owner or engineer to assist in the development of the MOP.
d. Development of the startup and commissioning documents for the power system. These document shall be submitted to the engineer and the third party commissioning service for review. The system integrator shall attend any meetings as required by the owner or engineer to assist in the development of the startup and commissioning documents.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver control sections in sections of lengths that can be moved past obstructions in delivery path. Shipping sections to be reviewed and approved by the engineer and installing contractor.

B. The Contractor shall store control system components indoors in clean dry space with uniform temperature to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.9 PROJECT CONDITIONS

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. All interruptions shall be per the approved per the construction Method of Procedure
2. Notify Construction Manager no fewer than 4 weeks in advance of proposed interruption of electric service.
3. Do not proceed with interruption of electric service without Owner's written permission.
4. Outages to existing loads shall occur during off hours.

a. If contractor elects to do outages or switchovers during normal hours then contractor shall submit a plan to be approved by the owner and provide temporary power at no additional cost.

D. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:

1. Ambient temperature not exceeding 122 deg F.

2. Altitude of 100 ft. above sea level.

1.10 WARRANTY

A. Manufacturer's Warranty: The power system integrator shall replace any components associated with the switchgear automation system that fail in materials or workmanship within the specified warranty period and provide assistance to all 3rd-party equipment vendors as needed to support interfacing with the switchgear automation system.

1. Warranty Period: Two year(s) from date of Owners written acceptance.

2. The system integrator shall include quarterly visits over the two year period to assist owner with operational questions and/or concerns that arise to assist owner with running the system.
3. The power system integrator shall provide a contract for the entirety of the Warranty period for maintenance, inspection and warranty management in the OWNERS best interest.

PART 2 - PRODUCTS

2.1 POWER SYSTEM INTEGRATORS.

A. Power system integrators: Subject to compliance with requirements, provide products and services by one of the following:
1. GSI Power Systems
2. Rockwell Automation
3. Thermo Systems
4. Approved equal
   a. Alternate system integrator may be submitted for approval

2.2 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. The Medium Voltage switchgear must be manufactured in accordance with specification 261300 Medium Voltage Switchgear. No exceptions.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for the paralleling switchgear, including clearances between paralleling switchgear and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. The multiple-generator paralleling monitoring and control panel for the medium voltage switchgear shall monitor and control the following standby power system components:

1. Medium voltage switchgear normal and emergency, all breakers. This includes:
    a. North Switching Station
    b. Howard Hall 15kV Switchgear
    c. Howard Hall Paralleling Switchgear
    d. Peaking Plant Paralleling Switchgear
    e. Capability for expansion to include Future South Switching Station
2. Low Voltage Switchgear, all breakers, including:
    a. Howard Hall 480V Switchgear
    b. Bressler Research Building 480V Switchgear
3. Single-generator monitoring and control system.
4. Single-generator paralleling monitoring and control systems that are incorporated into each individual engine generator.
5. Engine generators.
6. Other load-control devices.

E. The Medium Voltage Switchgear and Low Voltage Switchgear specified includes overcurrent and protective devices. The switchgear manufacturer shall provide equipment that meets the Short Circuit and Coordination Study encompassing the entire power system, performed by the engineer of record. The third party testing agency shall test all protective devices and ensure they are set to match the short circuit and coordination study settings for each protective device.

F. The power system Control Sections shall be free standing cabinets listed and labeled UL508A. The Control Section will house the controls inclusive of the PLCs, power supplies, isolation relays etc. for a complete power control system. The Control Sections shall house all the required control components to meet the specification requirements for a functional system. All communications between control sections, switchgear and other ancillary device locations shall be a dedicated fiber optic self-healing ring.

G. The automation and control system shall facilitate overall paralleling operations including automatic standby operation, monitoring and control of the generator sets including start/stop, alarm/fault monitoring, synchronizing, generator kW load sharing, generator kVAR load sharing, generator loading/unloading, load shed/add, power factor control when in utility paralleling operation, and protective relaying.

H. The automation and controls shall utilize true redundant master PLC based control system. The system shall be a bump less hot swap transfer to the redundant master controller without the loss of control of the power system. Each master control PLC shall be housed in segregated and separate enclosures for fault isolation. Communications shall be via fiber optic communication.

I. The generator paralleling switchgear automation interface shall be via a touchscreen with the following characteristics:
   1. Color, 19" diagonal TFT LCD display capable of displaying both text and graphics.
   2. The display shall support a minimum resolution of 1280x1024 pixels, 16 million displayable colors 24-60kHz horizontal scan rate, 56-75kHz refresh rate.
   3. The touchscreen shall be clear glass with light transmission of 95% or better furnished with a Surface Acoustic Wavetouch interface
   4. The generator paralleling switchgear touchscreen controller shall contain no moving parts.
   5. The Master Control Panel (MCP) and the Switchgear shall have a redundant HMI for full control of the system from any of the control section locations.

J. HMI Screen Listing
   1. The switchgear automation shall provide the following screens. The screens shall provide all of the information, metering, control, annunciations settings and indications listed below:
   2. Main Menu Screen with a complete listing of major screens.
   3. System Overview Screen with animated graphic display of the electrical one line.
   4. Electrical one-line screens for the individual switchgears.
   5. System Control Screen
   6. System Metering Screen.
   7. System Settings Screen.
   8. Generator set control screen for each generator set
   9. Generator set metering screen for each generator set.
   10. Generator set settings Screen
   11. Generator set demand priority control and status screen
   12. Generator set load shed control and status screen
   13. Engine monitoring screens for each generator that shall contain a graphical representation of all of the engine gauges and data specified
   14. Utility control screen.
   15. Utility metering screen
   16. Utility setting screen.
   17. Password entry screen that shall contain a numeric keypad for password entry
   18. Alarm summary screen that shall contain a time/date stamped system alarm summary. Alarm log shall be exportable to external media.
   19. Annunciator screens as follows:
   20. System annunciation screen that shall contain status, lamp test and alarm points.
   21. Generator set annunciator screen for each generator set that shall contain status, lamp test, pre-alarms and shutdown faults.

22. Utility annunciation screen that shall contain status, lamp test and alarm points.
23. Report Menu Screen
24. System settings report
25. Generator set settings report
26. Plant test report – including all current operational parameters
27. Alarm summary report
28. System real time trend screen.
29. Generator set real time trending screens
30. Historical trending package.

K. Remote Monitoring and Notification Capabilities - The automation system shall include the capability for remote PCs to view the HMI graphics via web pages and view system one-lines, real-time data, alarm and event logs, etc. The system shall also include the capability to remotely send text messages and/or email on alarms and events.

2.3 SWITCHGEAR AUTOMATION CONTROL FEATURES

A. The generator paralleling switchgear automation and controls shall consist of the hardware and software required for the control of the engine-generator plant and associated utilities, tie, and distribution circuit breakers. The system shall include all automation controllers, HMI (Human Machine Interface) touchscreens, power transducers, supervisory networks and all ancillary control equipment necessary to automatically execute the specified functional sequence of operations.

B. The switchgear control system shall be capable of recognizing when breakers and buses are racked out/unavailable.

C. The switchgear automation and controls shall be provided with an HMI consisting of a touchscreen display located in each control section Listed below:
1. Master Control Panels (MCP)
2. Switchgear Control Panels (SCP)
3. Additional sections as required

D. The HMI shall provide all metering, status, monitoring, and control information to the operator.

E. The HMI shall serve only as an operator interface. The paralleling controls must continue to function normally with a complete HMI failure.

F. The paralleling control automation and controls shall be designed to eliminate single points of failure.

G. For redundancy, multiple PLCs shall be utilized.
1. At a minimum, the switchgear controls shall utilize a separate controller for each power source i.e. utility, generators and tie breakers.

H. Control systems utilizing a single automation controller are not acceptable.

I. The generator paralleling switchgear automation and controls shall be capable of surviving a fault of one or more of its PLCs. The failure of any generator controller shall only cause loss of automatic operation of a single generator.

J. The paralleling controls shall be provided with redundant communication networks. The communications between the MCP and the Switchgear Control Panel(s) section shall be fiber optic self-healing ring bus

K. The failure of any single master PLC or utility PLC shall in no way hinder the full automatic operation of the entire generator paralleling switchgear automation and control system.

2.4 OPERATOR/SYSTEM SAFETY PROVISIONS

A. The Master Control Panel (MCP) shall be located in Howard Hall. The MCP shall contain a Master Auto/Manual (MAM) Switch that disables automated controls for the entire control system. HMI shall display an alarm when MAM switch is placed in Manual.

B. All Local Control Panels (LCPs) shall contain a Station Auto/Manual (SAM) Switch. The SAM switch shall disable automated controls for that station only. HMI shall display an alarm when SAM switch is placed in manual. There shall be SAM switches for the following Switchgear:

1. Howard Hall 15kV Switchgear (In MCP)
2. Howard Hall Generator Paralleling Switchgear (In MCP)
3. Peaking Plant Paralleling Switchgear
4. North Switching Station
5. Howard Hall 480V Switchgear (In MCP)
6. Bressler Research Building 480V Switchgear (In MCP)

C. In addition to the MAM and SAM switches, Local/Remote switches shall be provided. The Local/Remote switches shall prevent any remote control (automated or manually initiated from HMI) of the switchgear from the control system when in “Local”. When Local/Remote switch is in “Local” the HMI shall display an alarm. Switch shall be pad-lockable. The Local/Remote switch shall be located on the switchgear for each specific bus. Provide Local/Remote Switches for the following:

1. Howard Hall 15kV Switchgear (One L/R Switch for both buses)
2. Howard Hall Generator Paralleling Switchgear (One L/R Switch for both buses)
3. Peaking Plant Paralleling Switchgear (One L/R Switch for both buses)
4. North Switching Station Bus NA
5. North Switching Station Bus NB
6. North Switching Station Bus NC
7. North Switching Station Bus ND
8. Howard Hall 480V Switchgear (One L/R Switch for both buses)
9. Bressler Research Building 480V Switchgear (One L/R Switch for both buses)

D. Return to Utility Inhibit: Provide a software switch that prevents the automatic return to Utility power when the system is on Generators.

2.5 MASTER CONTROL FUNCTIONS

A. Master control redundancy shall be provided by two segregated and redundant automation controllers. One Master Controller shall be located in the MCP with the redundant controller located in a Switchgear Control Panel in close proximity to the MCP. Communications shall be redundant fiber optic communications.

B. Any required transfer of master control functions shall be transparent and concurrent operation with no loss of data on loss or transfer of redundant controllers.

C. Master control functions shall include:

1. Automatic start of the generator plant
2. First-up, dead-bus functions
3. Automatic generator demand priority
4. Load Bank Step Controls
5. Transfer inhibit to emergency/life safety ATS's to remain on life safety generators when campus standby generators are running. Specific ATS's in Howard Hall, Bressler Research Building, and MSTF that require this functionality are called out in the drawings.

D. The system controls shall include a generator demand priority control function to automatically match the on-line generator capacity to the loads, and avoid unnecessary operation of generator sets.

2.6 AUTOMATIC LOAD SHED / ADD

A. The load shed control shall have one essential load shed priority level for each generator in the system plus one non-essential load shed priority level (which is always shed in the emergency mode of operation).

B. The load shed control shall control each of the distribution circuit breakers as shown on the drawings. Distribution circuit breakers to be controlled shall be electrically operated. Each electrically operated distribution circuit breaker shall be field selectable to be assigned to any of the available load shed priority levels. The load shed system shall include individual breakers in the Medium-Voltage and Low-Voltage Switchgears that are connected to the control system.

C. The Owner shall be able to change the load shed priority of individual loads from the HMI screen.

2.7 GENERATOR SET CONTROL FUNCTIONS

A. For safety and availability, all generator set control functions shall be executed autonomously from each generator set PLC controller.

B. No master control coordination or intervention shall be required to affect the generator set control functions.

C. Existing Generator Control Upgrade:
1. Caterpillar 3508 750KW Engine Generators:

a. The 2 existing Caterpillar 3508 engine generators located on the roof of building HSF1 shall be retrofitted as described below. The engine generators shall be fully integrated into the new control and automation system. All alarms, available operating parameters and metering functions shall be displayed on the new control and automation HMI's.

b. The two existing 750 kW Caterpillar 3508 generator sets (serial# 23Z04908 and serial#23Z04905) are located remotely on the roof. The ASCO paralleling controls are located in the basement. The units do not have control panels located on the units. Engine control, voltage regulation and engine governing is accomplished buy a 2301 Woodward load sharing governor and a Basler voltage regulator located in the ASCO switchgear. The generator(s) must operate as a standalone unit capable of full control from a local control cabinet located inside the existing enclosure and full remote control via voltage bias signal, speed bias signal and remote start/stop. The units must have the capability to support a remote annunciator capable of displaying NFPA 11o alarm conditions. The following modifications are required:

1) Install a Caterpillar EMCP 4.2 controller. This controller must provide engine start/stop and all available engine and generator protection and monitoring. This controller must be capable of communicating to existing SCADA all engine metering, generator metering and alarm conditions via MODBUS 485 and MODBUS TCP/IP.
2) Replace existing Woodward 2301 Load sharing governor with and updated Woodward 2301 governor capable of controlling engine mounted EPG actuator. The new governor must be located in the new EMCP 4.2 control panel.
3) Replace existing Basler voltage regulator located in ASCO switchgear with a Caterpillar CDVR. The new CDVR must be located in the new EMCP 4.2 control panel.

2. Cummins Natural Gas Peaking/Standby Plant:

a. The existing Cummins natural gas 4MW peaking/standby plant shall be fully integrated into the new switchgear control and automation system. The plant shall be supplied with a SCP equipped with a HMI and integrated into the new control and automation system via fiber optic self-healing ring bus. The

new control and automation system shall control the Cummins units for speed, voltage, synchronization, and paralleling functions. All alarms, metering and engine parameters shall be displayed on the new control and automation system wide HMI network. Refer to "C" package drawings for details of existing peaking plant control system.

3. Cummins Diesel 1100KW and 1500KW (480VAC generators)

   a. The existing Cummins diesel engine generators located on the roof of the Howard Hall building shall be retrofitted to be independently controlled by the new control and automation system for paralleling. Refer to "B" package drawings for details of existing Howard Hall generator control panel wiring diagrams.

2.8 SYSTEM MASTER I/O

A. System master I/O shall be fully redundant, including horn, horn silence, instant auto selector, load shed on/off, and load shed relays

B. Transfers from primary to back-up system master I/O shall be transparent and bumpless.

C. Load Shed / Load Add Distribution Circuit Breaker I/O

D. Load shed / load add I/O shall be monitored and controlled via the supervisory network.

E. Load shed / load add distribution circuit breaker I/O shall include:

F. Circuit breaker auxiliary contact monitoring

G. Circuit breaker bell alarm contact monitoring

H. Close circuit breaker output

I. Open circuit breaker output

2.9 LOAD SHED / LOAD ADD DISTRIBUTION CIRCUIT BREAKER I/O REDUNDANCY

A. Load shed / load add I/O shall be fully redundant.

B. Transfers from primary to back-up load shed / load add I/O shall be transparent and concurrent operation with no loss of data on loss or transfer of redundant controllers.

2.10 SUPERVISORY NETWORK

A. The supervisory network shall consist of a non-proprietary topology and utilize open source protocols.

B. Supervisory network topology shall be EMI and RFI noise tolerant.

C. Supervisory network data rate shall be a minimum of 10Mbps.

D. All critical plant control data communication shall be deterministic with an update rate not to exceed 100ms.

E. The supervisory network shall be a fully dedicated network, providing high speed communication for the following:
   1. Communications of control data between distributed controllers
   2. Distribution of master control data
   3. Communications to and from the system HMI(s)
   4. Communications to and from the customer building management / BAS Interface.
   5. Communication to and from 3rd party balance of plant PLCs (as specified)
   6. Transfers from the primary to the back-up supervisory network shall be transparent and concurrent operation with no loss of data on loss or transfer of redundant controllers.

F. The Supervisory Network will also include the capability for fiber connection to UMB Facilities Network for remote viewing of HMI graphics, alarm and event logs, etc. The connection will be made at either Howard Hall or the North Electric Station.

2.11 CONTROL POWER REDUNDANCY

A. Paralleling controls automation control power system shall be protected against single point of failure by the utilization of a 125Vdc, best source DC system strategy. Each switchgear lineup control power system shall include the following features:
   1. Paralleling Switchgear and MCP
      a. The best source DC bus shall accept 125Vdc, through an isolation diode and circuit breaker, from each generator set battery.
   2. All control automation and controls shall be powered directly from this best source DC bus for each control panel.

2.12 ALARM LOG

A. The switchgear automation shall log all events and alarms with device, condition, and time/date stamp.

B. The system alarms inclusive of the automation and controls, protective relays HMI's and other devices shall be synchronized with the use of a GPS clock for fault analysis.

2.13 REAL TIME TRENDING

A. The switchgear automation shall support real time trending.

B. Real time trending shall display the following:
   1. Utility:
      a. Average voltage, average current, kW, kVAR.
   2. For each system generator set:
      a. Voltage, amps per phase, kW, kVAR, frequency, engine RPM, engine battery voltage, engine oil pressure, engine water temperature.

2.14 LONG TERM HISTORICAL TRENDING

A. Long term historical trending shall log switchgear data in non-volatile memory. This data shall be displayed in a strip chart format. Historical data file format shall be Microsoft compatible to facilitate manipulation of these files in other software programs.

2.15 MANUAL CONTROLS

A. Full manual backup control shall be provided for generator set voltage and frequency control.

B. Each power source breaker shall be provided with manual synchronizing scopes and associated (25) sync-check protective relays. The synchronizing scopes may be displayed on each HMI for all sources on the system on individual screens for each source. Software protective relays are not acceptable for manual operation functions.

C. Manual operation at the minimum shall allow a single generator to be placed on the bus and to carry the facility loads on a single engine generator up to the engine generator capacity. Each generator shall have the capability to be manually placed on the bus.

D. Demonstrate to the facility personnel the capability to manually control an engine generator without the use of the automation system.

2.16 SYSTEM METERING

C. The following metering information shall be displayed on the HMI for the system bus, each individual utility, tie, generator, and distribution breaker:
   1. Volts with 4-position selector switch to select three phases of voltage
   2. Amps with 4-position selector switch

3. Kilowatts
4. Kilovars
5. Frequency
6. Power Factor

D. All engine parameter data available on the generator set shall be accessible on the HMI.

2.17 PARALLELING SYSTEM ANNUNCIATION

A. The MCP's and SCP's shall be provided with local annunciation to monitor and display critical generator set, utility, and system status, fault, and shutdown information.

B. Annunciation shall comply with NFPA 110 requirements.

C. The annunciation system shall be equipped with a fast pulse horn (rated 80-95 dba at two feet), a horn silence push-button and an "Acknowledge" push-button. Any generator pre-alarm, generator shutdown alarm, or generator paralleling switchgear alarm shall cause the alarm horn to sound until the horn silence button is depressed. Any subsequent alarms shall re-sound the horn. The display shall operate such that any alarm point shall "flash" until acknowledged.

D. The annunciation system shall be provided with five (5) distinct types of annunciation points:
   1. Status Points – These annunciation points shall show the status of critical system or generator set components. Status annunciation points shall not sound the annunciation system horn. They shall not require acknowledgement.
   2. Generator Set Pre-Alarm Points – These annunciation points shall show fault conditions that could jeopardize the ability of the generator paralleling switchgear to function properly without immediate attention. Generator set pre-alarm annunciation points shall sound the annunciation system horn. They shall require acknowledgement. Generator set pre-alarm annunciation points shall reset automatically as the alarm condition is cleared.
   3. Generator Set Shutdown Alarm Points - These annunciation points shall show fault conditions that have caused the shutdown of one (1) or more generator sets. Generator set shutdown annunciation points shall sound the annunciation system horn. They shall require acknowledgement. Generator set shutdown annunciation points shall cause the generator set to shut down and the generator main to trip open. The generator main is then locked out until the cause of the shutdown is corrected, the engine control switch is placed in Off/Reset, and then placed back in Auto or Manual position.
   4. Utility Alarm Points – These annunciation points will indicate utility related fault conditions. Utility annunciation points shall sound the annunciation system horn. They shall require acknowledgement.

5. Generator paralleling switchgear Alarm Points – These annunciation points will indicate system wide fault conditions. The generator paralleling switchgear annunciation points shall sound the annunciation system horn. They shall require acknowledgement.

2.18 SEQUENCE OF OPERATION:

A. Load Shed/Add Control Logic

1. The System Controls shall include a Load Shed Control function to control the loads served by the generator plant. The Load Shed Control shall have one Essential Load Shed Priority Level for each generator in the system plus one Non-Essential Load Shed Priority Level (which is always shed in the Emergency Mode of operation).

2. The Load Shed Control shall control each of the distribution circuit breakers within the medium voltage switchgear and low voltage substations. Each electrically operated distribution circuit breaker shall be field selectable to be assigned to any of the available Load Shed Priority Levels. Additionally, Load Shed Control shall provide a 4 pole, 10A, 120VAC rated, form C set of contacts for each Load Shed Priority Level to allow for control of loads external to the switchgear.

3. The following controls shall be provided for each level:

   a. Shed Delay Timer, adjustable from 0 to 1024 seconds
   b. Add Delay Timer, adjustable from 0 to 1024 seconds
   c. Load Shed Override Selector (shed/auto//add)
   d. Status indicators to show whether the Priority Level is Added or Shed

4. The Load Shed Controls shall have:

   a. Load Shed Control Switch (On/Off)
   b. User-settable Load Shed % (as a function of on-line generator capacity)
   c. User-settable Load Add % (as a function of on-line generator capacity)
   d. User-settable Bus Under frequency Set point
   e. User-settable Bus Under frequency time delay
   f. Bus Under frequency Reset Pushbutton
   g. Bus Under frequency indicator

5. Conditional Load Shed: Upon entrance into Emergency Mode of operation, the Load Shed Control shall shed all Essential and Non-Essential loads. As generators come to the bus, Essential Priority Level loads shall be added conditionally based on the number of generators on line. When the first generator comes to the bus, Priority Level 1 loads shall be added; Second generator, priority 2, etc. After a time

delay that allows all operational generators to come to the bus, Load Shed Mode shall shift to Load Sensitive Mode.

6. Load Sensitive Load Shed – After all generators have been given sufficient time to come to the bus, load shed shall shift to "Load Sensitive" mode. The system shall compare current generator on-line capacity (in kW) to current load requirements. If surplus capacity is greater than the calculated Load Add setpoint, after the Load Add Time Delay the next Load Shed Priority will be added. This calculation will continue until all Sheddable Loads are added, or until surplus capacity is less than the calculated Load Add setpoint. If surplus capacity is less than the calculated Load Shed setpoint, after the Load Shed Time Delay the next Load Shed Priority will be shed. This calculation will continue until all Sheddable Loads are shed, or until surplus capacity is greater than the calculated Load Shed setpoint. The Load Shed Control, in its automatic shedding and adding of loads, shall not override any manual load shed/add operation.
7. Should the load bus frequency fall below the user selected bus underfrequency setpoint for a period longer than the bus underfrequency time delay, then all Priority Level loads shall be shed and load addition shall not resume until the operator has depressed the Bus Underfrequency Reset button. The bus underfrequency protection shall override any manual load add operation.

B. Generator Demand Priority Control

1. The System Controls shall include a Generator Demand Priority Control function to automatically match the on-line generator capacity to the loads to avoid unnecessary operation of all the generators when the loads are low.
2. The following controls shall be provided for each generator:
   a. User-settable Generator Priority Selector
   b. Status indicator for the Generator Priority Selected
   c. Status indicator for generator On-line or Off-line
3. The Generator Demand Priority Control shall have the following controls:
   a. Generator Demand Priority Control Switch (On/Off)
   b. User-settable Generator Remove % (as a function of a single generator capacity)
   c. User-settable Generator Remove Delay
   d. User-settable Generator Add % (as a function of a single generator capacity)
   e. User-settable Generator Add Delay
4. Upon entrance into Emergency or Load Management modes, all generators shall be started and paralleled to the bus. After the Remove Time Delay, generators shall be removed from the bus as a function of the generator percentage loading by the

user selected Generator Remove time delay. Generators shall be removed from the bus in descending priority. Should the generator percentage loading increase to the user selected Generator Add limits for the user selected Add Delay, the next generator will be started, synchronized and paralleled to the bus. Generators shall be added to the bus in ascending priority order. Should the generator plant ever reach 95% loading, the next priority generator shall be started and added to the bus with no time delay.

C. Load Management Mode – Demand Response

1. Entry

a. The Siemens Building Automation System (BAS) will send signals to the switchgear control system to enter demand response mode and start the generators. Separate signals will be provided for running the specific number of diesel gensets versus number of natural gas-fired gensets. The Power System Integrator will be responsible for connecting with the Siemens BAS:

1) Coordinate with Siemens BAS at the North Station (existing BAS panel is located in 2nd Floor Room #24) and receive a minimum of ten (10) contact inputs from the BAS for remote initiation of Peak Shaving by EACH INDIVIDUAL Generator from the BAS. Also assume the gear automation system will provide up to ten (10) contact outputs to the BAS for relaying general and common alarm information to the BAS (for alerting BAS system operators of systemic electrical events). Coordinate with Owner to identify alarms for relaying to BAS system.

b. A run request is sent to the generator plant natural gas generators and the diesel engine generators equipped with SCR's for operation during Demand Response.

c. The generators are allowed to run for a five-minute warm-up time (which can be abbreviated by the operator).

d. After completion of the warm-up time the first generator up to rated voltage and frequency is closed to the HH 15KV Generator Switchgear load bus. The automation dead bus logic will prevent 2 source breakers attempting to close onto the bus simultaneously.

e. The remaining HH 15KV generators are synchronized and paralleled to the HH 15KV Generator bus as they reach rated voltage and frequency. The Peaking Plant will concurrently start and synchronize its engine generators to the 15KV Peaking Plant load bus. After all Demand Response compliant generators are on the load bus or the expiration of the adjustable fail to synchronizing timer, factory set at 2 minutes the Peaking Plant will synchronize to the HH 15KV Generator Switchgear load bus and close the priority paralleling breaker G2 in the HH 15KV Generator Switchgear.

f. The generator plant is soft ramp loaded until it is serving nominally the required amount of the load on the bus to meet the mode of operation selected.

g. The generator output is dynamically adjusted to maintain the set point to meet the mode of operation selected.

h. Should the utility fail at any time during Load Management operation, the utility protective relays shall cause the utility mains to open and be locked out, thus placing the system in Emergency Mode until the Utility is restored (as described in Emergency Mode exit).

2. Exit

a. The Siemens BAS System will remove the peaking shaving enable contact to the switchgear automation system or the operator will manually disable peak shaving mode.

b. The generator plant is soft ramp unloaded until the utility source is nominally serving the facility loads.

c. The 15KV Generator Emergency tie breakers HNA and HNB are opened by the automation logic at the user adjustable KW disconnect set point, factory set at 100KW.

d. Peaking Plant Tie breaker G2 located in HH 15KV Generator Switchgear is opened.

e. All generator main paralleling breakers are opened.

f. The generators are allowed to run for their programmed cool down period.

g. The system is now back in Automatic/Standby Mode.

3. Demonstration

a. The power system integrator shall be responsible for demonstrating successful operation of peak shaving remotely from the Siemen's BAS system.

2.19 SOURCE QUALITY CONTROL

A. Simulated System Testing: Before the Electrical Power Monitoring and Control system is implemented, demonstrate a simulated system to the Owner and Owner's representative. The simulated system shall include a virtual single line showing all switchgear, breakers, and generators. The programming for the Sequence of Operation as described in specification 261302 shall be included. Manual and Automatic control of the system shall be demonstrated to show a complete working control system. Submit testing plan a minimum of 4 weeks before factory testing.

B. Testing: Test and inspect switchgear controls at switchgear manufacturer's factory.

1. Switchgear:

a. Switchgear and Control manufacturer to Provide Factory Witness test scripts to the owner 12 weeks after release of order for manufacture for evaluation and comment.
b. Factory test with simulated inputs. Test control and relay functions for proper operation.
c. Perform a complete sequence of operations test with failure scenarios.

C. Switchgear controls, will be considered defective if it does not pass tests and inspections.

D. Coordinate scheduling of the factory witness test with the Owner. Perform Fcatory Witness Test successfully prior to customer witness test.

E. Schedule Customer Witness test for owner 2 weeks prior to scheduled shipment. Include cost of the Factory Witness Test, Customer Witness Test airfare and Hotel accommodations for the Owner and (4) Owner reps

F. Prepare test and inspection reports.

G. Owner will witness all required factory tests. Contractor to provide accommodations if more than 50 mi from site. Notify Owner at least 14 days before date of tests and indicate their approximate duration.
1. Attendance or non-attendance by the Owner and/or their duly authorized representatives at factory tests shall not relieve the manufacturer of responsibility to correct any defects or items of non-conformance with these specifications discovered during site testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, where paralleling switchgear will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance of the Work.

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

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 260553 "Identification for Electrical Systems."

B. Diagrams and Instructions:

1. Frame and mount under clear acrylic plastic on front of paralleling switchgear.

a. Operating Instructions: Printed basic instructions for paralleling switchgear, including control and interlock sequences and emergency procedures.
b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.

2. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual, including Lockout and Maintenance Procedures and Consolidated Sequence of Operations.

3.3 CONNECTIONS

A. Comply with grounding and bonding requirements in Section 260526"Grounding and Bonding for Electrical Systems."

3.4 FIELD QUALITY CONTROL TESTING

A. Factory Witness Testing: The Owner reserves the right to inspect the equipment at equipment manufacturing facility for conformance with this specification prior to shipment. The Vendor shall notify the Owner in writing at least 14 working days prior to commencement of factory tests to permit the Owner the option of witnessing such tests. Under no condition will the equipment be released for shipment without prior notice of factory tests and witness test or waiver by the Owner. All re-tests due to improper notice or test failure shall be conducted, as required, at the Vendor's expense.

1. Release by the Owner to ship, or waiver of inspection or test witnessing in no way shall relieve the Vendor of responsibility for the equipment being in conformance with this specification and applicable standards.
2. Any material or equipment contained therein which, upon inspection, are found to contain defects, shipping damage, improper construction, excessive repairs, used parts, or not in accordance with this specification are subject to rejection by the Owner. The Owner reserves the right of rejection at the job site if the above conditions are discovered even after factory acceptance.
3. In general, the Vendor shall perform all tests on the switchgear as required to verify the proper operation of each component and controls. A recommended factory test procedure shall be provided by the Switchgear Vendor and approved by the Owner.
4. The control logic shall fully demonstrate the sequence of operation to the satisfaction of the owner and/or the owner's representatives.
5. The FWT shall include single point of failure testing for conformance to the specifications.
6. Vendor to include full cost for four individuals to witness testing cost to include travel, hotel, meals and local transportation.

B. Site Tests: Prior notification of all site tests shall be required. Site tests shall be witnessed by the Owner's representative. Scheduling of site tests shall be coordinated with the Owner's prior to startup. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.
3. Similar to the factory witness test, the vendor shall provide a demonstration of the control logic to fully demonstrate the sequence of operation to the satisfaction of the owner and/or the owner's representatives prior to commissioning. Provide 4 weeks' notice prior to test.
4. Conduct tests for reconditioned generators. Verify controller functionality.

C. Testing Agency: Engage a qualified, NETA certified testing agency to perform tests and inspections.

D. Prepare test and inspection reports.

E. Test sequence of operation step by step for each mode with the owner and commissioning representative.

3.5 CLEANING

A. On completion of installation, inspect interior and exterior of paralleling switchgear. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair damaged finishes.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to paralleling switchgear, according to manufacturer's written instructions, throughout periods when paralleling switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain paralleling switchgear and controls.

B. Training shall include 4 hours of classroom instruction and 16 hours of hands on instruction. Training shall be digitally recorded for the owner.

C. An additional training session shall be held with the Owner 6 months after the initial training session. Training shall include 8 hours of hands on training. The Owner shall submit to the trainer 1 month prior to training a list of questions and or topics to be addresses during this training session.

END OF SECTION 262313

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Disconnecting and overcurrent protective devices.
3. Instrumentation.
4. Control power.
5. Accessory components and features.
6. Identification.

1.3 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuits current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.

7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Include selectable ranges for each type of overcurrent protective device.

9. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing, maintaining and adjusting overcurrent protective devices.
3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Include selectable ranges for each type of overcurrent protective device.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Member Company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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.

F. Comply with NEMA PB 2.

G. Comply with NFPA 70.

H. Comply with UL 891.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and [install temporary electric heating (250 W per section) to prevent condensation.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.6 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: Not exceeding 104^0F (40^0C).
    b. Altitude: Not exceeding 6600 feet (2000 m).

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify UMB, in writing, no fewer than 10 days in advance of proposed interruption of electric service.

2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without UMB's written permission.
4. Comply with NFPA 70E.

1.7 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Potential Transformer Fuses: Equal to 10% of quantity installed for each size and type, but no fewer than two (2) of each size and type.
2. Control-Power Fuses: Equal to 10 % of quantity installed for each size and type, but no fewer than two (2) of each size and type.
3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 % of quantity installed for each size and type, but no fewer than three (3) of each size and type.
4. Fuses for Fused Switches: Equal to 10 % of quantity installed for each size and type, but no fewer than three (3) of each size and type.
5. Fuses for Fused Power-Circuit Devices: Equal to 10 % of quantity installed for each size and type, but no fewer than three (3) of each size and type.
6. Indicating Lights: Equal to 10 % of quantity installed for each size and type, but no less than one of each size and type.
7. Provide Fuse cabinet, to location coordinated with Owner.

1.10 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one (1) of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. Front- and Side-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

C. Nominal System Voltage: 480Y/277 V.

D. Main-Bus Continuous: 400 A.

E. Indoor Enclosures: Steel, NEMA 250, Type 1.

F. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's ANSI 49 gray finish over a rust-inhibiting primer on treated metal surface.

G. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

H. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

I. Buses and Connections: Three-phase, four-wire unless otherwise indicated.

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, with copper feeder circuit-breaker line connections.
2. Ground Bus: 1/4-by-2-inch hard-drawn copper of 98 % conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
4. Neutral Buses: 100 % of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

J. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

a. Instantaneous trip.
b. Long- and short-time pickup levels.
c. Long- and short-time time adjustments.
d. Ground-fault pickup level, time delay, and I^2t response.

2.3 INSTRUMENTATION – Refer to Section 262713 “Electricity Metering” & 260913 “Electrical Power Monitoring & Control”

2.4 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.5 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

B. Permanent Engraved Phenolic Nameplates: Provide white with black lettering ID plates for each circuit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, four (4) inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on eighteen (18) inch (450-mm) centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install filler plates in unused spaces of panel-mounted sections.

F. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

G. Comply with NECA 1.

3.3 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Division 26 Section "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.

B. Comply with requirements for terminating cable trays specified in Division 26 Section "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

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

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each switchboard. Remove front and side panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard eighteen (18) months after date of Substantial Completion.
    c. Instruments and Equipment:

        1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

    d. Follow NFPA 70E requirements

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. Switchboard will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 PERFORMANCE REQUIREMENTS

1.5 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

6. Include wiring diagrams for power, signal, and control wiring.
7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Also include selectable ranges for each type of overcurrent protective device.

C. Qualification Data: For qualified testing agency.

D. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For installation in panel boards. Submit final versions after load balancing.

F. Operation and Maintenance Data: For panel boards, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for maintaining, testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. 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.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.8 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: Not exceeding 23^0F to plus 104^0F.
    b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify UM, in writing, no fewer than 10 days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without UM's written permission.
3. Comply with NFPA 70E.

1.9 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other

types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.11 EXTRA MATERIALS

A. Revise this article to include extra materials that Owner may require, such as GFCI or GFEP circuit breakers or circuit breakers used for switching service, which may fail more frequently due to continuous use.

B. Coordinate with Division 26 Section "Fuses" for quantities of spare fuses and spare-fuse cabinet to be provided.

C. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Twospares for each panelboard.
3. Fuses for Fused Switches: Equal to 10 % of quantity installed for each size and type, but no fewer than three (3) of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 % of quantity installed for each size and type, but no fewer than three (3) of each size and type.
5. Provide and install fuse cabinet.

1.12 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

   a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
   b. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
3. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
4. Finishes:

   a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two (2) coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   b. Back Boxes: Galvanized steel.

5. Directory Card: Inside panelboard door, mounted in transparent card holder.

B. Incoming Mains Location: Top or bottom fed as needed

C. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 % conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 % of phase bus and UL listed as suitable for nonlinear loads.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 % conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device as needed.

6. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
7. Extra-Capacity Neutral Lugs: Rated 200 % of phase lugs mounted on extra-capacity neutral bus.

E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Mains: Circuit Breaker

D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug in circuit breakers.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

F. Breaker Spaces: Provide 99” of available breaker space.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or main lugs only as designated on contract drawings.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.
4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
5. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
f. Handle Clamp: Loose attachment for holding circuit-breaker handle in on position.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

C. Mount top of trim 90 inches above finished floor unless otherwise indicated.

D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

E. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

F. Install filler plates in unused spaces.

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

H. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

   a. Initial Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard eleven (11) months after date of Substantial Completion.
   c. Instruments and Equipment:

      1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Comply with NFPA 70E.

E. Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.

2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical twenty four (24) hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 % between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

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SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Snap switches and wall-box dimmers.
3. Wall-switch and exterior occupancy sensors.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

1.3 SUBMITTALS

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

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70, "National Electrical Code".

1.5 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

1.6 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Cooper; 5351 (single), 5352 (duplex).
b. Hubbell; HBL5351 (single), CR5352 (duplex).
c. Leviton; 5891 (single), 5352 (duplex).
d. Pass & Seymour; 5381 (single), 5352 (duplex).

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Cooper; XGF20.
b. Pass & Seymour; 2095.

2.4 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
d. Pass & Seymour; PS20AC1 (single pole), PS20AC2 (two pole), PS20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A:
1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Cooper; 2221PL for 120 V and 277 V.
b. Hubbell; HPL1221PL for 120 V and 277 V.
c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
d. Pass & Seymour; PS20AC1-PLR for 120 V.

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Cooper; 1995.
b. Hubbell; HBL1557.
c. Leviton; 1257.
d. Pass & Seymour; 1251.

2.5 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Hubbell Lighting.
2. Leviton Mfg. Company Inc.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Novitas, Inc.
5. Sensor Switch, Inc.
6. TORK.
7. Watt Stopper (The).

B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of one (1) minute to fifteen (15) minutes.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, and Class 2 power source as defined by NFPA 70.
4. Mounting:

a. Sensor: Suitable for mounting in any position on a standard outlet box.
b. Relay: Externally mounted through a one half (1/2) inch knockout in a standard electrical enclosure.
c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from two (2) fc to two hundred (200) fc; keep lighting off when selected lighting level is present.
8. Auxiliary Contacts: Ceiling mounted occupancy sensors shall have two sets of dry contacts.

C. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage. Operating frequency shall be 40K hertz or higher.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than twelve (12) inches in either a horizontal or a vertical manner at an approximate speed of twelve (12) inches/s.
2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of six hundred (600) sq. ft. when mounted on a ninety six (96) inch-high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of one thousand (1,000) sq. ft. when mounted on a ninety six (96) inch-high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of two thousand (2,000) sq. ft. when mounted on a ninety six (96) inch-high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within ninety (90) feet when mounted on a ten (10) foot-high ceiling in a corridor not wider than fourteen (14) feet.

D. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of six (6) inch-minimum movement of any portion of a human body that presents a target of not less than thirty six (36) sq. in., and detect a person of average size and weight moving not less than twelve (12) inches in either a horizontal or a vertical manner at an approximate speed of twelve (12) inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of one thousand (1,000) sq. ft. when mounted on a ninety six (96) inch-high ceiling.

2.6 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces0.035-inch- thick, satin-finished stainless steel.
3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.
4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant thermoplastic with lockable cover.

2.7 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: White, unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.

3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Occupancy Sensors: Unless otherwise indicated on contract drawings, all sensors shall be dual technology type.

J. Adjust locations of floor service outlets and power poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 % or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 262726

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
5. UMB Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Manufacturer's field service report.

F. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.5 Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. 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.

E. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22^0F and not exceeding 104^0F.
2. Altitude: Not exceeding six thousand six hundred (6,600) feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by UMB or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify UMB no fewer than ten (10) days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without UMB's written permission.
4. Comply with NFPA 70E.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 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. Fuses: Equal to 10 % of quantity installed for each size and type, but no fewer than three of each size and type.
2. Fuse Pullers: Two (2) for each size and type.

1.9 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 or 600 V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position. Fuses shall be rated for an interrupting capacity of 200,000 amps.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Auxiliary Contact Kit: **One** NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
6. Hookstick Handle: Allows use of a hookstick to operate the handle.
7. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 or 600 V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4X non-metallic.
3. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Install individual floor-mounted switches and circuit breakers with tops at uniform height, utilizing properly secured channels anchored to floor and ceiling.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

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

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker eleven (11) months after date of Substantial Completion.

c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study".

END OF SECTION 262816

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SECTION 262933 - CONTROLLERS FOR FIRE-PUMP DRIVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Full-service, full-voltage controllers rated 600 V and less.

1.3 DEFINITIONS

A. ATS: Automatic transfer switch(es).

B. ECM: Electronic control module.

C. MCCB: Molded-case circuit breaker.

D. NO: Normally open.

E. PID: Proportional integral derivative.

F. VFC: Variable-frequency controller(s)

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each type of product indicated.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Show tabulations of the following:

a. Each installed unit's type and details.
b. Enclosure types and details for types other than NEMA 250, Type 2.
c. Factory-installed devices.
d. Nameplate legends.
e. Short-circuit current (withstand) rating of integrated unit.
f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.
g. Specified modifications.

4. Include diagrams for power, signal, alarm, control wiring, and pressure-sensing tubing.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Product Certificates: For each type of product indicated, from manufacturer.

C. Source quality-control reports.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product indicated to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

1.7 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. Indicating Lights: Two of each type and color of lens installed; twoof each type and size of lamp installed.
2. Auxiliary Contacts: One for each size and type of magnetic contactor installed.
3. Power Contacts: Three for each size and type of magnetic contactor installed.
4. Contactor Coils: One for each size and type of magnetic controller installed.
5. Relay Boards: One for each size and type of relay board installed.
6. Operator Interface: One microprocessor board(s), complete with display and membrane keypad.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of an NRTL.

B. Source Limitations: Obtain fire-pump controllers and all associated equipment from single source or producer.

1.9 FIELD CONDITIONS

A. Environmental Limitations:

1. Ambient Temperature Rating: Not less than 40 deg F (5 deg C) and not exceeding 122 deg F (50 deg C) unless otherwise indicated.
2. Altitude Rating: Not exceeding 6600 feet (2010 m) unless otherwise indicated.

B. Interruption of Existing Electric Service: Notify Owner no fewer than seven days in advance of proposed interruption of electric service, and comply with NFPA 70E.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 20 and NFPA 70.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 FULL-SERVICE CONTROLLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Fire Pump Controllers:
   a. ASCO; a brand of Vertiv.
   b. Eaton.
   c. Hubbell Incoroporated.
   d. Master Control Systems, Inc.

B. General Requirements for Full-Service Controllers:

1. Comply with NFPA 20 and UL 218.
2. Combined automatic and nonautomatic operation.
3. Factory assembled, wired, and tested; continuous-duty rated.

C. Method of Starting:

1. Pressure-switch actuated.

a. Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
b. System pressure recorder, electric ac driven, with spring backup.
c. Programmable minimum-run-time relay to prevent short cycling.
d. Programmable timer for weekly tests.

2. Magnetic Controller: Across-the-line type.
3. Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of all electric or pressure actuators.

D. Method of Stopping: Automatic and nonautomatic shutdown after automatic starting.

E. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at controller location.

F. Method of Isolation and Overcurrent Protection: Interlocked isolating switch and nonthermal MCCB; with a common, externally mounted operating handle, and providing locked-rotor protection.

G. Door-Mounted Operator Interface and Controls:

1. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
2. Method of Control and Indication:

a. Microprocessor-based logic controller, with multiline digital readout.
b. Membrane keypad.
c. LED alarm and status indicating lights.

3. Local and Remote Alarm and Status Indications:

a. Controller power on.
b. Motor running condition.
c. Loss-of-line power.
d. Line-power phase reversal.
e. Line-power single-phase condition.

4. Audible alarm, with silence push button.
5. Nonautomatic START and STOP push buttons or switches.

H. Optional Features:

1. Extra Output Contacts:

    a. One NO contact(s) for motor running condition.
    b. One set(s) of contacts for loss-of-line power.
    c. One each, Form C contacts for high and low reservoir level.

2. Local alarm bell.
3. Door-mounted thermal or impact printer for alarm and status logs.
4. Operator Interface Communications Ports: USB, Ethernet, and RS485.

I. ATS:

1. Complies with NFPA 20, UL 218, and UL 1008.
2. Integral with controller as a listed combination fire-pump controller and power transfer switch.
3. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
4. Allows manual transfer from one source to the other.
5. Alternate-Source Isolating and Disconnecting Means: Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current, with an externally mounted operating handle; circuit breaker shall be provided with nonthermal sensing, instantaneous-only short-circuit overcurrent protection to comply with available fault currents.
6. Local and Remote Alarm and Status Indications:

    a. Normal source available.
    b. Alternate source available.
    c. In normal position.
    d. In alternate position.
    e. Isolating means open.

7. Audible alarm, with silence push button.
8. Nonautomatic (manual, nonelectric) means of transfer.

2.3 ENCLOSURES

A. Fire-Pump Controllers and ATS: NEMA 250, to comply with environmental conditions at installed locations and NFPA 20.
    1. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12 (IEC IP12).

B. Enclosure Color: Manufacturer's standard "fire-pump-controller red".

C. Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals, listings, and other pertinent data.

2.4 SOURCE QUALITY CONTROL

A. Testing: Test and inspect fire-pump controllers according to requirements in NFPA 20 and UL 218.

1. Verification of Performance: Rate controllers according to operation of functions and features specified.

B. Fire-pump controllers will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive equipment, with Installer present, for compliance with requirements and other conditions affecting performance.

B. Examine equipment before installation. Reject equipment that is wet or damaged by moisture or mold.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONTROLLER INSTALLATION

A. Coordinate installation of controllers with other construction including conduit, piping, fire-pump equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels. Ensure that controllers are within sight of fire-pump drivers.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Install controllers within sight of their respective drivers.

D. Connect controllers to their dedicated pressure-sensing lines.

E. Wall-Mounting Controllers: Install controllers on walls with disconnect operating handles not higher than 79 inches (2006 mm) above finished floor, and bottom of enclosure not less than 12 inches (305 mm) above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

F. Floor-Mounting Controllers: Install controllers on concrete base(s), using floor stands high enough so that the bottom of enclosure cabinet is not less than 12 inches (305 mm) above finished floor. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."

1. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.

G. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.3 POWER WIRING INSTALLATION

A. Install power wiring between controllers and their services or sources, and between controllers and their drivers. Comply with requirements in NFPA 20, NFPA 70, and Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 CONTROL AND ALARM WIRING INSTALLATION

A. Install wiring between controllers and remote devices and facility's central monitoring system. Comply with requirements in NFPA 20, NFPA 70, and Section 260523 "Control-Voltage Electrical Power Cables."

B. Install wiring between controllers and the building's fire-alarm system. Comply with requirements specified in Section 284621.11 " Addressable Fire-Alarm Systems."

C. Bundle, train, and support wiring in enclosures.

D. Connect remote manual and automatic activation devices where applicable.

3.5 IDENTIFICATION

A. Comply with requirements in NFPA 20 for marking fire-pump controllers.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification in NFPA 20 and as specified in Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

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

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

D. Acceptance Testing Preparation:

1. Inspect and Test Each Component:

    a. Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
    b. Test insulation resistance for each element, component, connecting supply, feeder, and control circuits.
    c. Test continuity of each circuit.

2. Verify and Test Each Electric-Drive Controller:

    a. Verify that voltages at controller locations are within plus 10 or minus 1 percent of motor nameplate rated voltages, with motors off. If outside this range for any motor, notify Owner before starting the motor(s).
    b. Test each motor for proper phase rotation.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Field Acceptance Tests:

1. Do not begin field acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to Owner and authorities having jurisdiction.
2. Prior to starting, notify authorities having jurisdiction of the time and place of the acceptance testing.
3. Engage manufacturer's factory-authorized service representative to be present during the testing.
4. Perform field acceptance tests as outlined in NFPA 20.

F. Controllers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.7 STARTUP SERVICE

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

1. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

A. Adjust controllers to function smoothly and as recommended by manufacturer.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, and timers.

C. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

D. Set field-adjustable pressure switches.

3.9 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.

B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

END OF SECTION 262933

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SECTION 263213 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes a packaged natural gas driven engine-generator set for power supply with the following features:

1. Natural gas driven generator set.
2. Unit-mounted radiator cooling system.
3. Unit-mounted control and monitoring.
4. Performance requirements for sensitive loads.
5. Outdoor enclosure.
6. Walk-in sound-attenuated enclosure.
7. SCADA or BMS interface via MODBUS TCP.

B. This Section also includes requirements for upgrading the existing engine-generator controls for existing Cummins' Diesel Units at Howard Hall and Bressler Research Building (see Part 2).

1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.4 REFERENCE STANDARDS

A. NEMA MG-1 – Motors and Generators

B. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

C. NFPA 37 - Standard for Installation and Use of Stationary Combustion Engines and Gas Turbines

D. NFPA 110 – Standard for Emergency and Standby Power Systems

E. IEC8528 Part 4 – Control Systems for Generator Sets

1.5 SUBMITTALS

A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Thermal damage curve for generator.
2. Time-current characteristic curves for generator protective device.
3. Engine performance and specs.
4. Alternator performance and specs.
5. Water jacket heater wattage, voltage and phases.
6. Silencer, wye fitting, flexible connections and connecting pipes.
7. Radiator duct flanges.
8. Output circuit breaker.
9. Control panel and monitoring system.
10. Exhaust piping, stack and components.
11. Enclosure, enclosure sound performance data, and ventilation calculations.
12. Battery, battery rack, battery charger, wiring diagrams, and components.
13. Muffler characteristics.
14. Information on engine characteristics:

a. Make, type, and number of cylinders
b. Brake horsepower (bhp) available
c. Jacket water heat rejection
d. Cooling pump characteristics
e. Space heat gain
f. Exhaust flow rate and temperature at 25, 50, 75 and 100% rated load
g. Ventilation requirements

h. Combustion air requirements
i. Fuel consumption rates at 25, 50, 75, and 100% rated load
j. Emission characteristics
k. Liquid refill capacities
l. Exhaust backpressure limitation
m. Type and manufacturer of governor
n. Alternator size to limit voltage dip to 10%

15. Information on generator characteristics:

a. Make and type
b. Type of construction and overspeed capabilities
c. Temperature rise
d. Regulation characteristics
e. Space heat gain
f. Ventilation requirements
g. Type of winding insulation
h. KW, KVA, power factor
i. Type of exciter and voltage regulator
j. Voltage, phase, wire
k. RPM
l. Winding pitch

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of enclosure, generator set, exhaust piping, and other components specified.

a. Outline drawings of equipment showing weights
b. Overall dimensions including bolting template and earthquake restraints
c. Right hand, left hand, end, and top views of proposed assembly
d. Stub ups/entrance location for fuel
e. Power and control wiring entrance locations
f. Lug sizes and locations
g. Overall dimensioned drawings of stairs and landings.

h. Weather protective enclosure installation drawings, structural calculations, lighting fixture catalog cut, panels, motor starters, transformer, conduit, and wiring.

2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting exhaust piping, supports, vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Wiring Diagrams: Power, signal, and control wiring.
5. Enclosure design temperature rise and ventilation calculations.
6. Exhaust piping and stack layout and sizing: Submit detailed engineering calculations and coordinated drawings of the exhaust piping system to include wye fitting, flexible connections, expansion joints, exhaust piping, stack, fittings and the silencer. Demonstrate that the exhaust piping is properly sized for the maximum allowable exhaust backpressure of the engine provided including a 15% safety/ service factor. Provide the calculation. Shop drawings shall indicate actual conditions, drawn to scale with dimensions.

C. Manufacturer Sizing Calculations: The manufacturer shall submit a generator sizing calculation to verify the generator will start and maintain the connected loads based on step loads of 25%, 50%, and 65%.

D. Manufacturer Seismic Qualification Certification: Submit certification that the engine-generator set, batteries, battery rack, accessories and components will withstand seismic forces. Include the following:

1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Interconnection detail drawing showing control and power connections of the complete system. Clearly differentiate between factory installed, vendor field installed, and contractor field installed wiring. Control connections between components are to be labeled with identical nomenclature. Coordinate with existing switchgear manufacturer.

F. Installation instructions for generators and exhaust piping components.

1. Accessories including fuel lines, flexible exhaust couplings, exhaust flange, and other exhaust system components.

G. Complete review of this specification, noting for each paragraph whether or not proposed equipment complies with project specifications, or deviates in some fashion. Justification must be provided for each deviation.

H. Complete test specification detailing testing procedure to be used to verify performance of equipment provided.

I. Test Reports:

1. Report of factory test on units to be shipped for this Project, showing evidence of compliance with the specified requirements.
2. Report of exhaust emissions showing compliance with applicable regulations and this specification section.
3. Report of sound generation.
4. Submit certified factory tests report on engine-generator delivery. Alarms, sensors, and meters must be tested and certified.
5. Submit, upon completion of installation and testing of engine-generator sets, certified test reports from load tests for engine-generator.

J. Field quality-control test reports.

K. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

L. Recommended spare parts list (with pricing) for beyond initial 2 years of operation.

M. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than 2 hours' normal travel time from Installer's place of business to Project site and shall be available on a 24-hour basis.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 50 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with ASME B15.1.

G. Comply with NFPA 37.

H. Comply with NFPA 70.

I. Comply with NFPA 99.

J. NEMA MG-1 – Motors and Generators

K. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

L. Engine Exhaust Emissions: Comply with applicable state and local government requirements and requirements specified in this section.

M. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation. Generator shall rest inside a noise attenuating enclosure provided by the manufacturer. Sound attenuating items include, but are not limited to, sound louvers, dampers, sound attenuated walls, intake baffles, and discharge baffles. Intakes shall prevent water penetration.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify UMB no fewer than 14 days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without UMB's written permission.

B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions outside the enclosure without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 5^0C to 40^0C.
2. Altitude: Sea level to 1000 feet.

1.8 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Provide services of a professional rigging company, where necessary, to provide proper handling and positioning of unit.

C. Provide all labor and material, storage, etc. for receiving the equipment, storage, transportation to the project site and installation into final location.

1.9 WARRANTY

1. Warranty: Full parts and labor warranty to repair or replace any defective component due to manufacture or installation defect.
2. Warranty Period: 5 years or 7,500 hours from project's date of Substantial Completion (not the vendor's date).

1.10 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 24 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide all parts and supplies same as those used in the manufacture and installation of original equipment.

1.11 EXTRA MATERIALS

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. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: Two sets each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide a natural gas driven engine-generator with a sound attenuated weather enclosure, subject to compliance with the requirements, as manufactured by:

1. Onan/Cummins Power Generation; Industrial Business Group.
2. Caterpillar; Engine Div.

2.2 UPGRADE EXISTING GENERATOR CONTROLS

A. Coordinate with the Power System Integrator and upgrade engine-generator controls for the following generators to Cummins' PC3.3, Woodward EASYGEN-3500XT or approved equal:

1. Howard Hall, 1150kW, Model # DFLB-3378008, Serial # I990992998
2. Bressler Research Building, 1500kW, Model # 1500DFLE-4326, Serial # G040674914

2.3 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

1. kW/kVA @ 0.8 pf: 2000kW/2500kVA
2. Rating: Continuous Duty
3. Voltage: 13.2/7.6kV

4. Phase: 3
5. Wire: 4

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:

1. Fuel: Natural Gas
2. Power Output Ratings: kW/kVA @ 0.8 pf: 2000kW/2500kVA
3. Voltage: 13.2/7.6kV
4. Phase: 3
5. Wire: 4
6. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
7. Heavy duty, single bearing, pre-lubricated type.
8. Alternator Insulation System Temperature Rise: 105^0C.
9. Self ventilating via direct drive blower.
10. Maximum speed not greater than 1800 rpm.
11. Flexible coupling of generator shaft to engine flywheel.
12. Self-regulating: Revolving field, 4-pole, brushless AC exciter with rotating rectifiers or static-exciter regulator assembly.
13. Stator twice impregnated with varnish, skewed to minimize heating and harmonics.
14. Excitor shall be full-wave rectifier with silicon diodes mounted on rotor shaft. Manual reset circuit breaker shall protect field circuit.
15. Class "H" for 150^0C rise over a 40^0C ambient, as defined by NEMA Standard MG1-1.65.
16. 2/3 Pitch. Sub transient Reactance: Maximum of 12%.

D. Generator-Set Performance for Non-Sensitive Loads:

1. Accept 65% block load.
2. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.

3. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
4. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
7. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.

E. Factory Prototype Test Certified

1. Harmonic Distortion Levels

   a. Demonstrate

2. Airflow Restriction tests

   a. Demonstrate controlled shutdown after overheating

3. Unit tested with enclosure
4. 30 Degree Water Spray Unit Rain Test

   a. Demonstrate no water leakage into electrical boxes

5. Overload Test

a. Demonstrate 10% overload with no damage to engine

6. Air Filter Test

a. Demonstrate engine contains engine backfire explosion

F. Factory Production Test Certified

1. Alternator Impedance to Ground
2. Dielectric Testing
3. Maximum kW Rating
4. Engine Response Time
5. Alternator Construction Testing

a. Impedance Balance Tested

6. Alternator Insulation Testing

a. Surge Tested

2.4 ENGINE

A. Fuel: Natural Gas.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines (2-Cycle engines are not permitted): 2250 fpm.

D. Nox Emissions: 0.5 g/bhp/hr

E. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.

2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
4. The lubrication system shall be of the full pressure type.
5. Replaceable full flow oil filters.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system.

1. Thermostatically controlled isolation valves for servicing. Provide disconnect switch at generator.

G. Governor: Adjustable isochronous, with speed sensing.

1. Cummins EFC, Woodward 2301, or equal.
2. Frequency variation shall not exceed +/- 0.25% for constant loads from 0-100%.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer. Fill engine cooling system with solution of 50/50 mix ethylene glycol at initial fill.
2. Size of Radiator: Adequate to contain thermal expansion of total system coolant from cold start to 110 percent load condition.

    a. Radiator Cooling (CFM)
    b. Generator Cooling (CFM)

3. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
4. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

a. Rating: 1.5 times the maximum operating pressure and temperature but not less than 50-psig working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

I. Muffler/Silencer: Critical Grade type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Muffler/Silencer:

a. Performance: Sound level measured at a distance of 60 feet from exhaust discharge after installation is complete shall be 61dBA at 300-3000 Hz or less.
b. Construction: Heavy duty carbon steel with ANSI connections sized for application. Inlet to silencer shall be on the bottom, side discharge.
c. Connections: ANSI Flanged.
d. Finish: High heat black or silver paint.
e. Pressure drop range: 6” to 11” WC. Note that silencer shall be selected based on consideration of the overall exhaust piping system pressure drop including safety/service factors and the maximum allowable engine backpressure.

2. Size silencer, wye fitting and piping to ensure that the measured exhaust back pressure does not exceed maximum limitations recommended by unit manufacturer including safety factor.
3. Catalytic Converter: Generator manufacturer shall provide a catalytic converter (as necessary) to comply with Federal Air Emissions Standards 40 CFR Part 60 JJJJ.
4. Condensate Drain for Muffler: Schedule 40, black steel pipe connected to silencer drain outlet through a petcock.
5. Exhaust Piping Connection: Provide piping, wye fittings and flexible joints for connection to engine complete with necessary fittings, flanges, gaskets, bolts, and nuts.

J. Engine Wye Fittings

1. Description: Provide wye fitting (if required) in generator enclosure when engine has two exhaust outlets. Wye fitting shall combine exhaust from dual outlet engines for more efficient outflow distribution.
2. Construction: All welded, carbon steel with 321 stainless steel corrugated flex hose.

3. Connections: Provide ANSI flanges. ANSI flanges may be replaced with engine flanges.
4. Pressure drop range: 6” to 11” WC. Note that the wye fitting shall be selected based on the engine and silencer configuration and in consideration of the overall exhaust piping system pressure drop including safety/service factors and the maximum allowable engine backpressure.
5. Size silencer, wye fitting and piping to ensure that the measured exhaust back pressure does not exceed maximum limitations recommended by unit manufacturer including safety factor.

K. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

L. Starting System: 24-V electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.

    a. Lead calcium type batteries.
    b. CCA rated per engine manufacturer for 0 degrees F starting.
    c. Non-metallic, corrosion resistant rack.
    d. Champion, Interstate, Exide, C&D Charter, or equal.

5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.

8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

   a. Operation: Equalizing-charging rate of 20 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
   b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
   c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
   d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
   e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
   f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.5 CATALYTIC CONVERTER FOR FEDERAL AIR EMISSIONS COMPLIANCE

A. Provide Manufacturer's recommended Oxidation Catalyst Solution and Catalyst Monitoring System with permanent test ports to ensure compliance with Federal Air Emissions Standards 40 CFR Part 60 JJJJ Table 1:

   1. Gasket-less Catalytic Converter/Silencer Housing.
   2. 304 Stainless Steel Construction.
   3. Extra Capacity for Catalyst Element.
   4. Unlimited type, size and quantity monitoring ports.

B. Per Section 3.6, coordinate with Maryland Department of the Environment (MDE) and perform all testing necessary to ensure compliance with all Federal and State Air Emissions requirements for non-emergency use and receive certification compliance.

2.6 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

C. Indicating and Protective Devices and Controls:

1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.
10. Low gas pressure alarm.
11. Generator overload.
12. Failed to synchronize.

D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

E. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote generator control switchgear. Coordinate connection requirements with the generator control switchgear integrator.

F. Common Remote Audible/Visual Alarm: Include necessary contacts and terminals in control and monitoring panel.

1. Overcrank shutdown.
2. Low oil pressure.
3. High engine temperature.
4. Overspeed.
5. System ready.
6. Low battery voltage.
7. High engine temperature (pre-alarm).
8. Low oil pressure (pre-alarm)
9. Coolant low-temperature alarm.
10. Control switch not in auto position.
11. Battery-charger malfunction alarm.
12. Battery low-voltage alarm.
13. Auxiliary alarm.
14. Auxiliary (pre-alarm).
15. Ground fault indication.
16. Engine running.

G. Automatic Shutdown Control:

1. Emergency stop.
2. Fail to crank.
3. High AC voltage.
4. High coolant temperature.
5. Low AC voltage.
6. Low oil pressure.
7. Over-crank.
8. Over-speed.
9. Short circuit.
10. Under-frequency.
11. Low coolant level.

H. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing

switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

1. Overcrank shutdown.
2. Low oil pressure.
3. High engine temperature.
4. Over-speed.
5. System ready.
6. Low battery voltage.
7. High engine temperature (pre-alarm).
8. Low oil pressure (pre-alarm)
9. Coolant low-temperature alarm.
10. Control switch not in auto position.
11. Battery-charger malfunction alarm.
12. Battery low-voltage alarm.
13. Auxiliary alarm.
14. Auxiliary (pre-alarm).
15. Ground fault indication
16. Engine running.

I. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Insulated-case, electronic-trip type; 100 percent rated; complying with UL 489.

1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H minimum.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Dripproof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

K. Subtransient Reactance: 12 percent, maximum.

L. Manual digital adjustment.

M. Synchronous operation for immunity to SCR tracking.

N. Steady state output voltage maintained at +/- 0.5% of rated voltage from 0-100%

O. Output voltage recovery to +/- 1% of final voltage in less than 4 seconds after adding/removal 25% load increments.

2.9 NEUTRAL GROUNDING RESISTOR

A. Resistor

1. 8,000 kV, 400 Amp, 10 second rated.
2. The neutral grounding resistor (NGR) shall utilize edge wound stainless steel load resistors of sufficient mass to withstand the rated current and prescribed duty.
3. The entire resistor assembly shall be mounted on insulators rated for the system voltage.
4. All resistor terminals and interconnections between the resistor units shall be stainless steel using stainless steel hardware.
5. Connections between resistors and bushing or current transformers shall be solid copper or stainless steel bus, or copper cables.

B. Enclosure

1. The NGR shall be supplied with a NEMA 3R louvered, hot dip galvanized enclosure with stainless steel hardware suitable for outdoor installation.

C. Accessories

1. The NGR shall be provided with a bar type ground fault current transformer (CT). The CT shall be connected to the NGR and have terminals for field wiring connections. A NEMA 4X junction box shall be provided with shorting terminal blocks for the CT connections.

2.10 NATURAL GAS SERVICE METER ASSEMBLY

A. Turbine Meters: Comply with ASME MFC-4M

1. Manufacturers: Subject to compliance with requirements, provide UL Listed products by Sensus or equal.
2. Housing: Cast iron or welded steel.

3. Connection Threads or Flanges: Steel.
4. Turbine: Aluminum or plastic.
5. Turbine Bearings: Self-lubricating, ABEC L10 bearing life.
6. Compensation: Continuous temperature.
7. Meter Index: Cubic feet.
8. Tamper resistant.
9. Remote meter reader compatible.
10. Maximum Inlet Pressure: 100 psig.
11. Accuracy: Maximum plus or minus 2.0 percent.

B. Gas Volume Corrector.

1. Manufacturers: Subject to compliance with requirements, provide products by KEP; Roots Meters & Instruments; Dresser, Inc. or equal
2. Instrument Drive Mounted.
3. Automatic bi-directional index drive.
4. 4-20mA output connector configured to provide a 4-20mA output to the switchgear ION7650 meters.
5. MODBUS TCP Communications - In addition to the 4-20mA signal output, meter shall also include optional MODBUS TCP Communications Card. Connect meter to Campus Facilities Network Switch in Generator Paralleling Switchgear Enclosure via CAT6 cable.
6. Accuracy: -40^{0}F to 140^{0}F.
7. Corrected Volume: +/-0.5%

2.11 SOUND ATTENUATED ENCLOSURE

A. The generator set shall be housed in a ruggedly constructed, weatherproof aluminum enclosure enclosing control panel, battery charger, circuit breaker and all other generator-mounted devices. The enclosure shall have inspection doors located at all control and maintenance points for easy access. Doors shall be complete with continuous piano hinge gasketing and key locking handles. Expanded metal louvers or hoods shall be located for cooling air inlet. Roof shall be one-piece construction with provisions for exhaust pipe penetration and support of silence and exhaust pipe. A minimum of two lifting eyes shall be provided for hoisting of enclosure only. A steel perimeter frame shall be provided for mounting onto the generator set skid rails. All penetrations for conduit, piping, exhaust, etc. shall be sealed to maintain weatherproof and sound attenuating properties. Sound attenuation shall reduce noise levels to 61 dBA at a distance of 60 feet in all directions after installation is complete.

B. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 115 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure. Sound attenuation shall be 61 dBA at a distance of 60 feet after installation is complete.

C. Description: Prefabricated enclosure with the following features:

1. Maximum allowable overall dimensions for the enclosure is 44’-0” long by 14’-0” wide. There is no restriction on height.
2. Construction: Galvanized-steel, metal-clad, integral structural-steel-framed enclosure erected on concrete foundation.
3. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
4. Space Heater: Thermostatically controlled and sized to prevent condensation and to maintain batteries at an acceptable temperature (cold cranking).
5. Louvers: Equipped with bird screen and filter arranged to prevent exterior dust, birds, and rodents.
6. Hinged Doors: With padlocking provisions.
7. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents. Provide two position dampers. Louvers sized to prevent rain, snow, and water intrusion at full engine load and radiator airflow.
8. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components and noise criteria.
9. Silencer Location: External to enclosure on roof, provide integral steel support.
10. Provide natural gas detection system with automatic gas supply shutoff to engine.
11. Provide manufacturer’s standard paint finish.
12. Provide small exhaust fan, sized by generator manufacturer for a 10 Deg. F temperature rise at 94 Deg. F dry bulb design conditions, for when engine is not in operation.

D. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature outside the enclosure at top of range specified in system service conditions but not less than 40 Deg. C.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.

2. Automatic Dampers: At engine cooling-air inlet and discharge. Electric two position – open/close. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

E. Exterior Deck: The enclosure fabricator shall include any necessary exterior stairs to access all of access doors to the generator enclosure. Proposed configurations shall be provided to the Owner for approval prior to fabrication. Where two generators are side by side, subject to approval by the Owner a common platform and stair arrangement between the generators will be considered. Stairs and deck shall be constructed using galvanized steel or aluminum and be equipped with flanges and bolts to secure the platform to the enclosure and to the pad/ground below. Stairs and platform shall meet the following requirements.

1. Provide structure capable of handling a minimum deck loading of 500 lbs.
2. Stair treads and decking material shall be constructed utilizing a serrated welded steel bar grating material. Width of stairs and deck shall be 42”.
3. Touchup any scratches to the steel finish with galvanizing repair paint. High-zinc-dust content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

F. Interior Lights with Switch: Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.
2. DC lighting system for operation when remote source and generator are both unavailable.

G. Exterior Lights with Photocell: Factory-wired to package power panel, weatherproof-type fixture with cage, controlled via a photocell. Arrange to provide adequate lighting at enclosure door, stairs, and landings. Minimum of two fixtures per enclosure long side, one on each end.

H. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

2.12 CONCRETE EQUIPMENT PADS

A. Utilize existing concrete equipment pad for generator. Provide any additional required concrete equipment pad modifications for generator installation.

B. Anchor each generator by bolting steel unit rails to vibration isolators. Secure vibration isolators to concrete pad.

2.13 VIBRATION ISOLATION DEVICES

A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.14 FINISHES

A. Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.15 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Full load run.
3. Maximum power.

4. Voltage regulation.
5. Transient and steady-state governing.
6. Single-step load pickup.
7. Safety shutdown.
8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
9. Report factory test results within 10 days of completion of test.

C. Owner will witness all required factory tests. Contractor to provide accommodations if more than 50 mi from site. Notify Owner at least 14 days before date of tests and indicate their approximate duration.

1. Attendance or non-attendance by the Owner and/or their duly authorized representatives at factory tests shall not relieve the manufacturer of responsibility to correct any defects or items of non-conformance with these specifications discovered during site testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch on 4-inch- high concrete base. Secure sets to anchor bolts installed in concrete bases.

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

B. Connect engine exhaust pipe to engine with flexible connector.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 SERVICE-METER ASSEMBLY INSTALLATION

A. Install service-meter assemblies aboveground within generator enclosure.

B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.

C. Install strainer on inlet of service-pressure regulator and meter set.

D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.

E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.

F. Install service meters downstream from pressure regulators.

3.5 IDENTIFICATION

A. Identify system components according to Division 26 Section "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
c. Verify acceptance of charge for each element of the battery after discharge.
d. Verify that measurements are within manufacturer's specifications.

3. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

4. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
5. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
6. Exhaust Emissions Test: Upon completion and successful commissioning of the generator installation, coordinate with the Maryland Department of the Environment (MDE) and perform Air Emissions Testing on the generator to confirm compliance with Federal Air Emissions Standards 40 CFR Part 60 JJJ. Comply with all MDE test criteria.

    a. Provide permanent test ports in the exhaust system as necessary to accommodate this testing. After testing, the test ports shall remain for UMB's future use during their required periodic testing.

7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for manufacturer's recommended step-load increases and decreases, and verify that performance is as specified.
8. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
9. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations identified by the Owner, and compare measured levels with required values.

C. Coordinate tests with tests for transfer switches and paralleling switchgear and run them concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge system and test for leaks of coolant and fuel systems. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and retest as specified above.

I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

K. In addition, the following tests shall be provided in the field.

1. Four (4) hour full load test for each generator utilizing the UMB campus (peak shaving mode) for load. Record generator operating conditions at ten (10) minute intervals.
2. Load share test. Utilizing the UMB campus for loads (peak shaving mode) demonstrate load share capabilities of the generators from 10 to 100% load in 10% increments. Record generator operating conditions and performance at each increment level.
3. Test all alarm points, safety devices and engine shutdown.

L. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all success panels so terminations and connections are acceptable to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designated to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 263213

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SECTION 263533 - POWER FACTOR CORRECTION EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes automatic power factor correction equipment rated 13,800 volts.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions, operating characteristics of multiple capacitor cells or elements, and data on features, ratings, and performance.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, method of field assembly, components, and location and size of each field connection. Show access and workspace requirements and required clearances.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Qualification Data: Testing agency.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For equipment to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Lists of spare parts and replacement components recommended for storage at Project site.
2. Detailed instructions covering operation under both normal and abnormal conditions.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined in OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE 18 and NEMA CP 1.

D. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate sensor-communication module package with data network and with monitoring equipment specified in Division 26 Section "Electrical Power Monitoring and Control" for successful transmission and remote readout of remote monitoring data specified in this Section.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace capacitor-bank components that fail in materials or workmanship within specified warranty period.

1. Special Warranty Period for Capacitor Cells: Five years from date of Substantial Completion.

1.7 EXTRA MATERIALS

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. Deliver extra materials to Owner.

1. Fuses: 1 for every 5 of each type and rating, but not less than 3 of each.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the

following:

1. Automatic Power Factor Correction Units:
   a. Eaton
   b. ABB Control, Inc.
   c. General Electric Company; Business Information Center.
   d. Square D; Division of Schneider Electric.

2.2 CAPACITORS, GENERAL

A. Construction: Multiple capacitor cells or elements, factory wired in three-phase groups and mounted in metal enclosures.

B. Capacitor Cells: Low loss, double-bushing capacitors in accordance with IEEE Std. 18.

C. Cell Rupture Protection: Pressure-sensitive circuit interrupter for each cell.

D. Capacitor-Bank Fuses: Current-limiting, noninterchangeable type; factory installed in each phase and located within the equipment enclosure. Features include the following:

1. Interrupting Capacity: 50,000 A, minimum.
2. Fuse Ratings and Characteristics: As recommended by capacitor manufacturer.
3. Neon Indicator Lamp for Each Fuse: Connect to illuminate when fuse has opened, but is still in place, and locate so it is visible from outside the enclosure.

E. Discharge Resistors: Each capacitor shall contain an internal discharge resistor to reduce the stored voltage to 50 volts or less within 5 minutes from disconnection.

F. Enclosure: NEMA 250, steel or aluminum, arranged to contain the fluid leakage from capacitor cells; factory equipped with mounting brackets suitable for type of mounting indicated.

1. Indoor Enclosures: NEMA 250, Type 12 or as indicated.

2.3 AUTOMATIC POWER FACTOR CORRECTION UNITS

A. Comply with all applicable NEMA and ANSI/IEEE standards.

B. Description: Capacitor banks, contactors, controls, and accessories factory installed in independent enclosures. Units include a separately mounted current transformer to sense current in the power circuit being corrected and to provide input to unit controls.

C. Performance Requirements: Controls permit selection of a target power factor, adjustable to any value between unity and 0.80 lagging. Controls continuously sense the power factor

on circuits being corrected and, when the power factor differs from the target setting for more than 10 seconds, operate a contractor to switch a capacitor bank into or out of the circuit. Contactors are opened or closed as required to bring the corrected circuit power factor closer to the target setting. Switch only one capacitor bank at a time.

D. Controls: Solid-state, microprocessor-based controls, including the following:

1. Undervoltage relay that interrupts capacitor switching and disconnects capacitors for power supply interruptions longer than 15 minutes.
2. "Advance" and "Retard" push buttons on the control panel to permit manually controlled capacitor-bank switching.

E. Contactors: Singe pole vacuum switches shall be used for staged capacitor switching.

F. Buses: Plated copper.

G. Fuses for Protection of Capacitor Banks: Rated to protect contactor, interconnecting wiring, and capacitors.

H. Inductors: Air-core-type, connected in capacitor circuits; rated to limit switching surges to within contactor ratings.

I. Precharge Capacitor Circuit: Resistive, precharge circuit to charge capacitors prior to switching and to limit switching surges to within contactor ratings.

J. Mechanical Bracing for Current-Carrying Parts: Adequate to withstand the maximum fault current to which they may be exposed.

K. Identification of Energized Capacitor Banks: LED indicating lamps on front panel.

L. Enclosure: NEMA 250, Type 12, steel or aluminum, with hinged door and hand-operated catch. Door shall be interlocked with controls or main circuit breaker to de-energize capacitors when door is opened.

M. Local Display: LED or liquid-crystal digital type, mounted in door of enclosure, indicating the following:

1. Target and actual power factors accurate to plus or minus 1 percent of reading.
2. Steps energized.
3. Step reconnection delay.
4. Real and reactive currents.
5. Voltage THD.
6. Alarm codes.

N. System Alarms: Alarm relay and local display indication of the following conditions:

1. Low power factor.
2. Leading power factor.
3. Frequency not detected.
4. Overcurrent.
5. Overvoltage.
6. Overtemperature.
7. Excessive voltage THD.
8. Capacitor overload.
9. Loss of capacitance.

O. Current Transformer: Type, configuration, and ratio to suit sensing and mounting conditions.

P. Load Interrupter Air Disconnect Switch: Integral disconnect switch, externally operated, mechanically chain driven with visible blades. Disconnect switch is mechanically interlocked with the ground switch. A barriers shall be provided to isolate live components.

1. Operating handle can be padlocked.

Q. Remote Monitoring Components: Sensors, associated communication modules, and network interface units, matched to and compatible with electrical power monitoring and control network. Communication module shall have capability to transmit the following data to the Siemens Building Automation System:

1. System in alarm.
2. Power factor set-point.
3. Corrected power factor.
4. Number of capacitor steps activated.

2.4 FACTORY FINISH

A. Manufacturer's standard enamel over corrosion-resistant treatment or primer coat.

2.5 SOURCE QUALITY CONTROL

A. Factory test power factor correction equipment before shipment. Comply with NEMA CP 1. Include the following:

1. Routine capacitor production tests, including short-time overvoltage, capacitance, leak, and dissipation-factor tests.
2. Functional test of all operations, controls, indicators, sensors, and protective devices.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install freestanding equipment on concrete bases. Cast-in-place concrete is specified in Division 03.

B. Maintain minimum workspace according to manufacturer's written instructions.

C. Connect remote monitoring communication module to electrical power monitoring and control data network through appropriate network interface unit.

D. Identify components according to Division 26 Section "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each power factor correction capacitor element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect capacitors, wiring, components, connections, and equipment installation. Test and adjust components, and equipment.
2. Assist in field testing of equipment[including pretesting and adjusting of automatic power factor correction units].
3. Report results in writing.

C. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

D. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS, "Capacitors and Reactors - Capacitors." Certify compliance with test parameters.

E. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.3 ADJUSTING

A. Adjust for optimum automatic power factor correction.

3.4 CLEANING

A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean components internally, on completion of installation, according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain automatic power factor correction units. Demonstrate method of determining optimum settings for system controls. Refer to Division 01 Section "Demonstration and Training."

B. Conduct a minimum of two hours' training as specified in Division 01 Section "Demonstration and Training."

END OF SECTION 263533

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SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches.
2. Bypass/isolation switches.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

C. Qualification Data: For manufacturer and testing agency.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain automatic transfer switches, bypass/isolation switches through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NEMA ICS 1.

F. Comply with NFPA 70.

G. Comply with NFPA 110.

H. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service, if needed.

1. Notify UMB no fewer than ten (10) days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without UMB’s written permission.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.7 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Contactor Transfer Switches:
   a. Emerson; ASCO Power Technologies, LP.
   b. GE Zenith Controls.
   c. Onan/Cummins Power Generation; Industrial Business Group.
   d. Russelectric, Inc.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 % of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 % or better over an operating temperature range of minus 20^0C to plus 70^0C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Switching. All switches shall be four-pole switches , provide neutral pole switched simultaneously with phase poles.

H. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

I. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device. Provide CAT 6E cable in conduit from remote communication.

J. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

K. Enclosures: General-purpose NEMA 250, Type 1], complying with NEMA ICS 6 and UL 508, unless otherwise indicated

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from one (1) second to thirty (30) seconds.

E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

F. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.

G. Automatic Transfer-Switch Features:

1. Maximum operating transfer time of one sixth (1/6) second.
2. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85% to 100 % of nominal, and dropout voltage is adjustable from 75% to 98 %of pickup value. Factory set for pickup at 95 % and dropout at 95 %.
3. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero (0) seconds to six (6) seconds, and factory set for three (3) seconds.
4. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85% to 100 % of nominal. Factory set for pickup at 95 %. Pickup frequency shall be adjustable from 90% to 100% of nominal. Factory set for pickup at 98%.
5. Time delay for Transfer to Emergency: Adjustable from zero (0) minutes to five (5) minutes, and factory set for zero (0) minutes.
6. Time Delay for Retransfer to Normal Source: Adjustable from zero (0) minutes to thirty (30) minutes, and factory set for ten (10) minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
7. Engine Cool Down Time: Adjustable from zero (0) minutes to thirty (30) minutes, and factory set for five (5) minutes.
8. Test Switch: Simulate normal-source failure.
9. Switch-Position Pilot Lights: Indicate source to which load is connected.
10. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

11. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
12. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
13. Engine Starting Contacts: One (1) isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
14. Engine Shutdown Contacts: Time delay adjustable from zero (0) minutes to five (5) minutes, and factory set for five (5) minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
15. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from seven (7) days to thirty (30) days. Running periods are adjustable from ten (10) minutes to thirty (30) minutes. Factory settings are for seven (7) day exercise cycle, thirty (30) minute running period, and five (5) minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available.

2.4 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Concrete Bases: Four (4) inches high, reinforced, with chamfered edges. Extend base no more than four (4) inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

B. Identify components according to Division 26 Section "Identification for Electrical Systems."

C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

D. Where generators serve more than one transfer switch, starting control is governed by the closing of engine start contacts at any one multiple transfer switches. Engines shall not shut down unless all associated transfer switches have transferred back to normal source and all cool-down time delays have expired.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Provide CAT 6E cable in conduit from ATS back to BAS main control panel.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.
b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
c. Verify that manual transfer warnings are properly placed.
d. Perform manual transfer operation.

5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
b. Simulate loss of phase-to-ground voltage for each phase of normal source.
c. Verify time-delay settings.
d. Verify pickup and dropout voltages by data readout or inspection of control settings.
e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one (1) pole deviating by more than 50 % from other poles.
g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

F. Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Substantial Completion, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch eleven (11) months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

3.5 START-UP SERVICES

A. The complete installation shall be initially started and checked for operational compliance by factory trained manufacturer's representative(s).

B. All settings, as specified in this section shall be property set and verified by start-up personnel.

C. Provide a written start-up and testing checklist which verifies all settings and features are properly set and functioning, written report shall indicate final setting of all adjustable features.

3.6 CLEANING

A. Upon completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish. Clean components internally using methods and materials recommended by manufacturer.

END OF SECTION 263600

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SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.2 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.3 SUMMARY

A. Section Includes:

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.
5.

1.4 DEFINITIONS

A. BF: Ballast factor.

B. CCT: Correlated color temperature.

C. CRI: Color-rendering index.

D. HID: High-intensity discharge.

E. LER: Luminaire efficacy rating.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.5 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. Ballast, including BF.
4. Lamps
5. Energy-efficiency data.
6. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.

    a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, details, and attachments to other work.

    1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Shop Drawings: All lighting fixtures shall include the following, in addition to the requirements of the Submittal section:

    1. Wiring Diagrams: For power, signal, and control wiring.

D. Samples: For each custom lighting fixture indicated in the Interior Lighting Fixture Schedule. Each Sample shall include the following:

    1. Lamps and ballasts, installed.
    2. Cords and plugs.
    3. Pendant support system.

E. Installation instructions.

F. Coordination Drawings: Reflected ceiling plan(s) 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. Lighting fixtures.
    2. Suspended ceiling components.
    3. Partitions and millwork that penetrate the ceiling or extends to within twelve (12) inches of the plane of the luminaires.
    4. Ceiling-mounted projectors.
    5. Structural members to which suspension systems for lighting fixtures will be attached.
    6. Other items in finished ceiling including the following:

        a. Air outlets and inlets.

b. Speakers.
c. Sprinklers.
d. Smoke and fire detectors.
e. Occupancy sensors.
f. Access panels.

7. Perimeter moldings.

G. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

H. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

I. Field quality-control reports.

J. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

K. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

D. Mockups: Provide interior lighting fixtures for room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of fixtures for mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

1.7 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.8 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. Lamps: Ten (10) for every one hundred (100) of each type and rating installed. Furnish at least one (1) of each type.
2. Plastic Diffusers and Lenses: One (1) for every one hundred (100) of each type and rating installed. Furnish at least one (1) of each type.
3. Fluorescent-fixture-mounted, emergency battery pack: One (1) for every twenty (20) emergency lighting unit.
4. Ballasts: One (1) for every one hundred (100) of each type and rating installed. Furnish at least one (1) of each type.
5. Globes and Guards: One (1) for every twenty (20) of each type and rating installed. Furnish at least one (1) of each type.

1.9 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five (5) years from date of Substantial Completion.

C. Special Warranty for Cord-Connected, Plug-in Surge Suppressors: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic equipment connected to circuits protected by surge suppressors.

D. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: Ten (10) years from date of Substantial Completion. Full warranty shall apply for two (2) years, and prorated warranty for the remaining eight (8) years.

2. Warranty Period for Self-Powered Exit Sign Batteries: Seven (7) years from date of Substantial Completion. Full warranty shall apply for two (2) years, and prorated warranty for the remaining five (5) years.

PART 2 - PRODUCTS

2.1 GENERAL REQIREMENTS

A. Refer to lighting fixture schedule on contract drawings for requirements.

2.2 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: One half (1/2) inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two (2), one half (1/2) inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gauge.

F. Rod Hangers: Three sixteenth (3/16) inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures:

1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
2. Install lamps in each luminaire.

B. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.

1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than six (6) inches from lighting fixture corners.
2. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two (2) three quarter (3/4) inch metal channels spanning and secured to ceiling tees.

C. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than forty eight (48) inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems.

3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265100

SECTION 270544 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 27.

1.2 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product specified in this section.

1.4 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than fifty (50) inches and with no side larger than sixteen (16) inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter fifty (50) inches or more and one or more sides larger than sixteen (16) inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

a. Manufacturers: Subject to compliance with requirements, provide products by the following Pre-sealed Systems.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5,000-psi, twenty eight (28) day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
b. Seal space outside of sleeves with mortar, grout, or silicone. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide one quarter (1/4) inch annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. De-burr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors two (2) inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work to maintain any existing warranties.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using PVC or steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for one (1) inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install PVC, steel sleeves. Size sleeves to allow for one (1) inch annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

3.2 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.

3.3 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.

END OF SECTION 270544

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SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 27.

1.2 SUMMARY

A. Section Includes:

1. Pathways.
2. UTP cabling.
3. 62.5/125 multi-mode, and single-mode optical fiber cabling.
4. Cable connecting hardware, patch panels, and cross-connects.
5. Telecommunications outlet/connectors.
6. Cabling system identification products.
7. Cable management system.

1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel.

D. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

E. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

F. EMI: Electromagnetic interference.

G. IDC: Insulation displacement connector.

H. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

I. LAN: Local area network.

J. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

K. RCDD: Registered Communications Distribution Designer.

L. Solid-Bottom or Non-ventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom without ventilation openings.

M. Trough or Ventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom having openings for the passage of air.

N. UTP: Unshielded twisted pair.

1.4 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.

1. TIA/EIA-568-C requires that a minimum of two (2) telecommunications outlet/connectors be installed for each work area.
2. Transition points or consolidation points are not allowed between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.
4. Splitters shall not be installed as part of the optical fiber cabling.

B. A work area is approximately one hundred (100) sq. ft. and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable length is two hundred ninety five (295) feet. This maximum allowable length does not include an allowance for patch cords at the workstation, and patch cords at the equipment room. System designer should plan for a combined cable length (horizontal cable length plus patch cord length) not to exceed three hundred twenty eight (328) feet.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-C, when tested according to test procedures of this standard.

1.6 SUBMITTALS

A. Product Data: For each type of product specified in this section.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
2. Cabling administration drawings and printouts.
3. Wiring diagrams to show typical wiring schematics, including the following:

    a. Cross-connects.
    b. Patch panels.
    c. Patch cords.

4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
5. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

    a. Vertical and horizontal offsets and transitions.
    b. Clearances for access above and to side of cable trays.
    c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
    d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

6. Provide layout drawings coordinated with receptacle locations shown.
7. Provide test reports with corrective measures documented.

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector, and RCDD

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. RCDD, testers, and installers shall be certified by the manufacturer of the product being installed.

1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of RCDD, who shall be available at all times when Work of this Section is performed at Project site. A Level 2 Installer must be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Twenty five (25) or less.
2. Smoke-Developed Index: Four hundred fifty (450) or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Telecommunications Pathways and Spaces: Comply with TIA-569-B-2004.

E. Grounding: Comply with ANSI-J-STD-607-A-2002 and all applicable sections of NFPA 70, NEC.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.
2. Test each pair of UTP cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Drywall, sanding, and all painting of all surfaces shall be completed before installing cable in equipment rooms.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with UMB's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area, unless otherwise noted on telecommunications drawings to meet ADA requirements.

1.11 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. Patch-Panel Units: One (1) of each type.
2. Connecting Blocks: One (1) of each type.

1.12 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-B-2004.

B. Support of Open Cabling: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Velcro straps.
2. J-hooks.

C. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems.

1. Outlet boxes shall be no smaller than two (2) inches wide, four (4) inches high and two and one half (2-1/2) inches deep.

2.2 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Berk-Tek; a Nexans company.
2. CommScope, Inc.
3. Mohawk; a division of Belden CDT.
4. Superior Essex Inc.
5. General Cable Company.
6. Siemon

B. Description: 22-24 AWG, solid copper conductors, 100-ohm, 4-pair UTP, nominal impedance +/- 15%, green CMP Plenum jacket and complies with EIA/TIA 568-C Cat 6 standard.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-C, Category 6.
3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

2.3 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Siemon Co.
2. Ortronics Corp.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-C, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same manufacturer and of same category or higher.

C. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One (1) for each conductor in assigned cables.

D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

E. Number of Jacks per Field: One (1) for each two-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

G. Patch Cords: Factory-made, four-pair cables in thirty six (36) inch lengths terminated with eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.

2.4 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Corning
2. SYSTIMAX Solutions; a CommScope, Inc. brand.
3. Optical Cable Corporation
4. Mohawk

B. Description: Multimode, 62.5/125-micrometer, 12-fiber, nonconductive, tight buffer, OM1, optical fiber cable. Single mode, 9/125-micrometer, 12-fiber, plenum-rated, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-C for performance specifications.
3. Comply with TIA/EIA-492AAAA-A for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.

5. Maximum Attenuation: 3.50dB/km at 850 nm; 1.0dB/km at 1300 nm for OM1 multimode, 1.0 dB/km at 1310 nm; 1.0 dB/km at 1550 nm for single mode.
6. Minimum Modal Bandwidth: 200 MHz-km at 850 nm; 500 MHz-km at 1300 nm for OM1 multimode.

C. Jacket:

1. Jacket Color: Orange for multimode and yellow for single mode.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-C.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.5 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Corning Cable Systems.

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in thirty six (36) inch lengths.

D. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-C
2. Connectors: Quick-connect, duplex, Type SC, as manufactured for each cable type with insertion loss not more than 0. 5 dB.

2.6 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-C Cat 6.

B. Workstation Outlets: Four-port-connector assemblies mounted in single faceplate.

1. Metal Faceplate: Stainless steel, complying with requirements in Division 26 Section "Wiring Devices."
2. For use with snap-in jacks accommodating any combination of UTP, SC optical fiber, and work area patch cords.

a. Flush mounting jacks, positioning the cord (downward) at a 45-degree angle.
b. Flush mounting jacks, positioning the cord at a 90-degree angle for wall phones only.

3. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.7 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with requirements of NFPA 70, NEC, National Electrical Code.

2.8 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.9 SOURCE QUALITY CONTROL

A. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-C.

B. Factory test UTP cables according to TIA/EIA-568-C.

C. Factory test multimode and single mode optical fiber cables according to and TIA/EIA-568-C.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including all deficiencies and corrective measures.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools to comply with manufacturer’s recommendations.

3.2 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-B-2004.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-B-2004 for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install vertical and horizontal cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits three (3) inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with ninety six (96) inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1-2010, The Standard Practice of Good Workmanship in Electrical Construction, and BICSI TDMM.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-C.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated. Terminate conductors; no cable shall contain un-terminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced.

5. Secure and support cables at intervals not exceeding thirty (30) inches and not more than six (6) inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Do not allow un-terminated cable to lay on floor, prior to installation. Remove and discard cable if damaged prior to and/or during installation and replace it in its entirety with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating. In the communications equipment room, install a ten (10) foot long service loop in the cable tray, on the backboard or on each end of cable.
9. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions and ensure manufacturer's specified tension limits are not exceeded.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-C.
2. Do not untwist UTP cables more than one half (1/2) inch from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-C.
2. Cable must be terminated on connecting hardware that is rack mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of eight (8) inches above ceilings by cable supports not more than forty eight (48) inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, equipment, or other potentially damaging items.

F. Conduit Installation:
1. Install conduit bushings at each end of conduit to avoid disturbing cable jacket. Provide pull string in spare conduits and label at both ends.

G. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.

3. Coil cable six (6) feet long not less than twelve (12) inches in diameter below each feed point.

H. Group connecting hardware for cables into separate logical fields.

I. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-B-2004 for separating unshielded copper voice and data 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 five (5) inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of twelve (12) inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of thirty six (36) 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 two and one half (2-1/2) inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of six (6) inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of eighteen (18) inches.

4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of twelve (12) inches.

3.4 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with TIA/EIA-569-B-2004, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A-2002.

C. Comply with NFPA 70-NEC.

D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least two (2) inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG green THHN/THWN insulated grounding electrode conductor from grounding bus bar to suitable electrical building ground.

E. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG green THHN/THWN insulated equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Administration Class: 3.

B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards.

C. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

E. Cable and Wire Identification:

1. Label each cable within two (2) inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is required to be numbered at device and numbered within panel or cabinet.

3. Label each terminal strip and screw terminal in each outlet jack, cabinet, rack, and panel.

   a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown. Identify with one label.
   b. Label each unit and field within distribution racks and frames.
   c. Each outlet shall have an identification code consisting of five (5) digits (six (6) if "LL" is used instead of "B"). The first digit shall indicate the floor of the building where the outlet is located. The letter "G" shall be used for the ground floor. One (1) for the first floor, etc. The letter "B" shall be used for basements, "S" for subbasement, "LL" for lower level, and "M" for mezzanine.
   d. The second digit shall be the closet identifier. The letter "N" shall be used to indicate the north closet, the letter "S" shall be used to indicate the south closet, the letter "E" shall be used to indicate the east closet, and the letter "W" shall be used to indicate the west closet. If there is only one closet per floor, we use the letter "N."
   e. The last three digits shall denote the number of the outlet. Outlet numbers one (1) through nine (9) shall be preceded with two zeros (e.g. 1N008). Outlet number ten (10) through ninety nine (99) shall be preceded with one zero (e.g. 1N028).
   f. In the Telecommunications Room, data patch panels will be labeled with both the outlet # and the jack #. For instance for outlet # 1N028, the patch panel will read 1N028-D1, and 1N028-D2.
   g. The color code for Communication Outlet Icons is as follows:

      1) Category 6 data jack “GREEN”
      2) ‘SC’ Fiber jack “RED”

4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware.

F. Labels shall be preprinted or computer-printed type with white printing area and black font color that complies with requirements in TIA/EIA-606-A.

   1. Labels on cables shall be flexible vinyl or polyester that flex as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-C.
2. Visually confirm Category 6 marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP horizontal copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination and before cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. Optical Fiber Cable Tests:

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and multimode horizontal link measurements: Test at 850 or 1300 nm in one (1) direction according to TIA/EIA-526-14-A, Method B, One (1) Reference Jumper.
        2) Attenuation test results for horizontal links shall be less than 1.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-C.

6. UTP Performance Tests:

    a. Test for each outlet. Perform the following tests according to TIA/EIA-568-C:

        1) Wire map.
        2) Length (physical vs. electrical, and length requirements).
        3) Insertion loss.
        4) Near-end crosstalk (NEXT) loss.
        5) Power sum near-end crosstalk (PSNEXT) loss.
        6) Equal-level far-end crosstalk (ELFEXT).

7) Power sum equal-level far-end crosstalk (PSELFEXT).
8) Return loss.
9) Propagation delay.
10) Delay skew.

7. Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests according to TIA/EIA-568-C.
8. Final Verification Tests: Perform verification tests for UTP and optical fiber systems after the complete communications cabling and workstation outlet/connectors are installed.

   a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.

C. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports noting all deficiencies and corrective measures

END OF SECTION 271500

SECTION 280544 - SLEEVES AND SLEEVE SEALS FOR ELECTRONIC SAFETY AND SECURITY PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section and all other sections of Division 28.

1.2 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.

1.4 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than fifty (50) inches and with no side larger than sixteen (16) inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter fifty (50) inches or more and one or more sides larger than sixteen (16) inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Presealed Systems.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5,000-psi, twenty eight (28) day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Silicone Foams: Multicomponent, silicone-based, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non shrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
b. Seal space outside of sleeves with mortar, grout or silicone. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide one quarter (1/4) inch annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors two (2) inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work to maintain any existing warranties

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using PVC or steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for one (1) inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install PVC or steel pipe sleeves. Size sleeves to allow for one (1) inch annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

3.2 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.

3.3 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.

END OF SECTION 280544

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SECTION 281300 - ACCESS CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 28.

1.2 SUMMARY

A. Section Includes:
   1. Card readers and door hardware for integration into existing access control system.
   2. in a level of quality consistent with other specified items.

1.3 DEFINITIONS

A. CCTV: Closed-circuit television.

B. CPU: Central processing unit.

C. Credential: Data assigned to an entity and used to identify that entity.

D. dpi: Dots per inch.

E. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.

F. GFI: Ground fault interrupter.

G. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

H. I/O: Input/output.

I. LAN: Local area network.

J. Location: A Location on the network having a PC-to-controller communications link, with additional controllers at the Location connected to the PC-to-controller link with a

TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.

K. PC: Personal computer. Applies to the central station, workstations, and file servers.

L. PCI Bus: Peripheral Component Interconnect. A peripheral bus providing a high-speed data path between the CPU and the peripheral devices such as a monitor, disk drive, or network.

M. PDF: Portable Document Format. The file format used by the Acrobat document-exchange-system software from Adobe.

N. PIB: Photo-Identification and Badging System.

O. RAS: Remote access services.

P. RF: Radio frequency.

Q. ROM: Read-only memory. ROM data are maintained through losses of power.

R. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

S. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.

T. UPS: Uninterruptible power supply.

U. USB: Universal serial bus.

V. WAN: Wide area network.

W. WAV: The digital audio format used in Microsoft Windows.

X. WMP: Windows media player.

Y. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.

Z. Windows: Operating system by Microsoft Corporation.

AA. Workstation: A PC with software that is configured for specific, limited security-system functions.

BB. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Diagrams for cable management system.
2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:

a. Workstation outlets, jacks, and jack assemblies.
b. Patch cords.
c. Patch panels.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installing company must be on a pre-approved list furnished by the owner for installation services for this project.

B. Providers of manufactured components, installation, wiring and testing shall be the responsibility of a single contractor who is an authorized dealer for the product supplied and who has been continuously in business for a period of not less than five (5) years and is licensed as required by the jurisdictions where the work will occur to perform the work specified. The security contractor shall meet the following performance requirements:

C. Authorized Lenel dealer: The security firm shall be a Lenel dealer in good standing.

D. Technician Certification:

1. Technical personnel shall be certified by the factory for the installation and service of all Lenel components.

E. Security License Requirements: The security contractor and "all" personnel at the company (including technical and administrative staff) shall be licensed by the State of Maryland for a security license with the appropriate background checks. All employees will have a formal background check and go through a drug-testing program during their initial hire in your firm as a standard procedure.

F. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1. Cable installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International.

G. Source Limitations: Obtain all components through one source from single manufacturer.

H. 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.

I. Comply with NFPA 70, "National Electrical Code."

J. Comply with FCC - Part 15, "Radio Frequency Devices".

K. Comply with FCC - Part 68, "Communication of Terminal Equipment to the Telephone Network".

L. Comply with UL 294, "Access Control System Units".

M. Comply with UL 1076, "Proprietary Burglar Alarm Unit and Systems".

N. Comply with IEEE, "Institute of Electrical and Electronics Engineers".

O. Comply with Microsoft® Open Database Connectivity (ODBC) interface.

P. Comply with ISO Software Coding Standards for C++ and C##.

Q. Comply with RoHS, "Restriction of Hazardous Substances".

R. Comply with SIA DC-01 and SIA DC-03 and SIA DC-07.

1.6 SYSTEM DESCRIPTION

A. Adding card readers for access control into existing buildings with existing Lenel security system in place.

1.7 CONTRACTOR PERFORMANCE REQUIREMENTS

A. Working Hours Response: During normal working hours, all telephone calls placed to the contractor shall be answered by a live person, not an auto-attendant.

B. The contractor must be a certified dealer of all products utilized in the system to include: Lenel, American Dynamics, Aiphone, Code Blue, HID, Pelco

1.8 SUBSTITUTIONS AND QUALITY:

A. Where products are specified by name, provide and install that product. Substitutions will not be accepted for the access control or digital CCTV system or their sub-systems.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Environmental Limitations: Do not deliver or install equipment until spaces are enclosed and weather tight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.10 COMMISSIONING AND STARTUP

A. Program all newly installed field hardware into the existing system. All controllers, door interfaces, input and output panels should be entered and configured per operational guidelines provided by the hospital.

B. Follow all applicable business rules utilized in the existing system.

C. Supply training for personnel for data entry of cardholder information, badge printing and access level assignments. Contractor is not responsible for cardholder creation or badge production.

1.11 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

B. The system components shall be guaranteed against all defective materials, design and workmanship for a period of two (2) years from the date of acceptance by the client after final testing. New replacement parts shall be furnished promptly and defects in design and workmanship shall be corrected, without cost to the Owner, promptly upon receipt of notice from the Owner of failure of any part of the system during the guarantee period. This is a one year full parts and labor warranty and no alternative will be acceptable.

C. Any item failing before the one (1) year guarantee period expires shall be replaced and the guarantee extended for that item for twelve (12) months from the replacement date of the item.

D. The warranty period for any part which has a warranty by the manufacturer of longer than twelve (12) months shall be for the longer period. Provide a copy of the manufacturer's warranty period statement for all alarm equipment, all software, all major components, and other major devices.

PART 2 - PRODUCTS

2.1 READER AND DOOR OPERATION

A. The card reader door, the system shall have the following operational capability:

1. Readers shall read cards while the door is in the open position.
2. Door shall lock automatically upon the door being opened.
3. Automatic locking of the door lock after the door has been opened can be delayed for a user-defined time period.
4. Alarm from the door shall be shunted following the presentation of a valid access card, activation of the request to exit device and/or the pressing of the exit button.
5. Shall include a separate (alternate) shunt timer to extend the door shunt time after an access granted access occurs when a valid card has been presented by an individual with special ADA requirements. This will be determined as a check box in that cardholder's card record, and will be user definable.
6. Each card reader door shall be monitored for both forced and propped open conditions. The system shall differentiate between the two types of conditions, and notify the alarm monitoring center of each specific alarm condition, initiating a different response for each alarm type.
7. All door locks for stairwells and exits shall have a master over-ride switch which will be placed at the Main Fire Control Panel location.
8. Inputs:

    a. Data from entry-control devices; use this input to change modes between access and secure.
    b. Database downloads and updates from the central station that include enrollment and privilege information.

9. Outputs:

    a. Indicate success or failure of attempts to use entry-control devices and make comparisons of presented information with stored identification information.
    b. Grant or deny entry by sending control signals to portal-control devices and mask intrusion-alarm annunciation from sensors stimulated by authorized entries.

c. Maintain a date-, time-, and Location-stamped record of each transaction and transmit transaction records to the central station.
d. Door Prop Alarm: If a portal is held open for longer than time listed in a schedule, alarm sounds.

10. With power supplies sufficient to power at voltage and frequency required for field devices and portal-control devices.
11. Data Line Problems: For periods of loss of communication with the central station, or when data transmission is degraded and generating continuous checksum errors, the controller shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal-control devices.

12. Controller Power: NFPA 70, Class II power-supply transformer, with 12- or 24-V ac secondary, backup battery and charger.
    a. Backup Battery: Valve-regulated, recombinant-sealed, lead-acid battery; spill proof. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.
    b. Backup Power-Supply Capacity: Four (4) hours of battery supply. Submit battery and charger calculations.
    c. Power Monitoring: Provide manual, dynamic battery-load test, initiated and monitored at the control center; with automatic disconnection of the controller when battery voltage drops below controller limits. Report by using local controller-mounted digital displays and by communicating status to central station. Indicate normal power on and battery charger on trickle charge. Indicate and report the following:

        1) Trouble Alarm: Normal power-off load assumed by battery.
        2) Trouble Alarm: Low battery.
        3) Alarm: Power off.

2.2 CARD READERS

A. Card-Reader Power: Powered from its associated controller, including its standby power source, and shall not dissipate more than 5 W.

B. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.

C. Enclosure: Suitable for surface, semi-flush, pedestal, or weatherproof mounting. Mounting types shall additionally be suitable for installation in the following locations:

1. Indoors, controlled environment.
2. Indoors, uncontrolled environment.
3. Outdoors, with built-in heaters or other cold-weather equipment to extend the operating temperature range as needed for operation at the site.

D. Display: Digital visual indicator shall provide visible and audible status indications and user prompts. Indicate power on or off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.

E. Touch-Plate and Proximity Readers:

1. The system shall use proximity readers manufactured by HID, and will use the "Thinline" series model of reader. Other manufacturers and product types are not acceptable.
2. The card reader shall read proximity cards in a range from direct contact to at least 6 inches from the reader.

F. Communication Protocol: Compatible with local processor.

G. Touch-Plate and Contactless Card Reader: The reader shall have "flash" download capability to accommodate card format changes. The card reader shall have capability of transmitting data to security control panel and shall comply with ISO/IEC 7816.

2.3 DOOR AND GATE HARDWARE INTERFACE

A. Exit Device with Alarm: Operation of the exit device shall generate an alarm and annunciate a local alarm. Exit device and alarm contacts are specified in Division 08 Section "Door Hardware."

1. Request to Exit Devices. Each card reader door will be equipped with a REX device manufactured by DSI. This will be a DSI 150I, and will enable the system to both differentiate and monitor the door for forced and prop open conditions.
2. Door Contacts. The status of each card reader door will be monitored with a magnetic door contact. This will be a Sentrol 1078C-W wide-gapped contact, no exceptions.

B. Exit Alarm: Operation of a monitored door shall generate an alarm. Exit devices and alarm contacts are specified in Division 08 Section "Door Hardware."

C. Electric Door Strikes: Use end-of-line resistors to provide power-line supervision. Signal switches shall transmit data to controller to indicate when the bolt is not engaged and the strike mechanism is unlocked, and they shall report a forced entry. Power and signal shall be from the controller. Electric strikes are specified in Division 08 Section "Door Hardware."

D. Electromagnetic Locks: End-of-line resistors shall provide power-line supervision. Lock status sensing signal shall positively indicate door is secure. Power and signal shall be from the controller. Electromagnetic locks are specified in Division 08 Section "Door Hardware."

2.4 CABLES

A. General Cable Requirements: Comply with requirements in Division 28 Section "Conductors and Cables for Electronic Safety and Security" and as recommended by system manufacturer for integration requirement.

B. PVC-Jacketed, TIA 232-F Cables:

1. Two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, and individual aluminum-foil/polyester-tape shielded pairs with 100 percent shield coverage; PVC jacket.
2. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
3. NFPA 70, Type CM.
4. Flame Resistance: UL 1581 vertical tray.

C. PVC-Jacketed, TIA 485-A Cables: Two pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMG.

D. Multiconductor, PVC, Reader and Wiegand Keypad Cables:

1. No. 22 AWG, paired and twisted multiple conductors, stranded (7x30) tinned copper conductors, semirigid PVC insulation, overall aluminum-foil/polyester-tape shield with 100 percent shield coverage, plus tinned copper braid shield with 65 % shield coverage, and PVC jacket.
2. NFPA 70, Type CMG.
3. Flame Resistance: UL 1581 vertical tray.
4. For TIA 232-F applications.

E. Paired, PVC, Reader and Wiegand Keypad Cables:

1. Three pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, individual aluminum-foil/polyester-tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 % shield coverage, and PVC jacket.
2. NFPA 70, Type CM.
3. Flame Resistance: UL 1581 vertical tray.

F. Paired, Lock Cables:

1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
2. NFPA 70, Type CMG.
3. Flame Resistance: UL 1581 vertical tray.

G. Paired, Input Cables:

1. One pair, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, overall aluminum-foil/polyester-tape shield with No. 22 AWG, stranded (7x30) tinned copper drain wire, 100 % shield coverage, and PVC jacket.
2. NFPA 70, Type CMR.
3. Flame Resistance: UL 1666 riser flame test.

H. Paired, AC Transformer Cables:

1. One pair, twisted, No. 18 AWG, stranded (7x26) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
2. NFPA 70, Type CMG.

2.5 TRANSFORMERS

A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with TIA/EIA 606-A, "Administration Standard for Commercial Telecommunications Infrastructure."

3.3 CABLING

A. Comply with NECA 1, "Good Workmanship in Electrical Construction."

B. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

C. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

D. Install end-of-line resistors at the field device location and not at the controller or panel location.

3.4 CABLE APPLICATION

A. Comply with TIA 569-B, "Commercial Building Standard for Telecommunications Pathways and Spaces."

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

C. TIA 232-F Cabling: Install at a maximum distance of fifty (50) feet.

D. TIA 485-A Cabling: Install at a maximum distance of four thousand (4,000) feet.

E. Card Readers and Keypads:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.
2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is two hundred fifty (250) feet, and install No. 20 AWG wire if maximum distance is five hundred (500) feet.
3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

F. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed two hundred fifty (250) feet.

G. Install minimum No. 18 AWG ac power wire from transformer to controller, with a maximum distance of twenty five (25) feet.

3.5 GROUNDING

A. Comply with Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

E. Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
2. Bus: Mount on wall of main equipment room with standoff insulators.
3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.6 INSTALLATION

A. Install card readers, keypads, push buttons, and biometric readers.

B. All electric locking and panic, and power transfer hardware will be supplied and installed by others. It is the security contractor’s responsibility to provide power and interface the security system to the electric hardware.

3.7 WIRING FIRESTOPPING

A. Comply with requirements in Division 07 Section "Firestopping."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

3.8 IDENTIFICATION

A. In addition to requirements in this article, comply with applicable requirements in Division 26 Section "Identification for Electrical Systems" and with TIA/EIA 606-A.

B. At completion, cable and asset management software shall reflect as-built conditions.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Operational Test: Verify card readers allow access for approved identification cards and reject access for non-approved cards. See Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 281300

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SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 28.

1.2 SUMMARY

A. Section Includes:

1. Fire alarm systems with manual stations, detectors, signal equipment, controls, digital amplifiers, booster panels, digital voice communication and devices.
2. Connection to door hardware for door closers/holders, electric door locks, and release existing devices that interface with fire alarm systems.

B. Section Includes:

1. Manual fire-alarm boxes.
2. System smoke detectors.
3. Heat detectors.
4. Notification appliances.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. FAS: Fire Alarm System.

C. FACP: Fire Alarm Control Panel.

D. GAP: Graphic Annunciator Panel.

E. NAC: Notification Appliance Circuit.

F. SLC: Signaling Line Circuit.

G. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

H. NICET: National Institute for Certification in Engineering Technologies.

I. BAS: Building Automation System

1.4 SYSTEM DESCRIPTION

A. Non-coded, UL-certified addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.

B. Non-coded addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.

C. General:

1. The existing fire alarm control panel for the buildings is a Notifier NFS2-640 with DVC Voice Command Unit. The Notifier NFS2-640 is currently monitoring an existing 3rd party panel that is acting as the main building panel. The current system is a horn/strobe system. Bidders will be responsible for supplying all components to complete a fully functional Emergency Voice Evacuation in accordance with the project specifications and drawings. The contractor is responsible for determining if the existing NFS2-640 panel will provide adequate capacity to support all required points/zones under this contract and if NFS2-640 cannot support the additional points/zones, than the panel shall be upgraded to Notifier Model NFS2-3030. The cost of any necessary upgrade to Notifier Model NFS2-3030 must be included in the lump sum base bid price. DO NOT PROVIDE Notifier Model NCA-2, network control annunciator for additional points/zones. UM does not monitor networks at the buildings.

2. Each day, the contractor and sub-contractors shall sign-in and sign-out at Campus Police Station located at 214 Pine Street, Baltimore, MD.

D. Prior to programming the fire alarm system at all buildings, the contractor shall contact UMB Project Manager to obtain available nodes.

E. Initiating Devices: Provide initiating devices for each application throughout as required by NFPA 72.

F. Provide interface connections for all elevator functions. If the buildings have multiple elevator controllers, provide monitor modules for each elevator.

G. Notification Appliances:

1. Provide combination speaker/strobe signals throughout as required to ensure audibility and intelligibility of signal as detailed in NFPA 72.

2. Provide additional non-textual visual appliances throughout the building to ensure all signals are visible to all occupants as required by the ADA.

H. Voice/Alarm:

1. During normal system operation, activation of any alarm initiating device shall cause an attention signal to be broadcast over audible signals to be followed by a custom voice message.

1.5 SUBMITTALS

A. General Submittal Requirements: Comply with the UMB General Conditions.

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:

a. Trained and certified by manufacturer in fire-alarm system design.
b. NICET-certified fire-alarm technician, Level IV minimum.
c. Licensed or certified by authorities having jurisdiction.

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

C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
2. Include voltage drop calculations for notification appliance circuits.
3. Load Calculations - Provide load calculations for all NAC circuits while noting both current demand future capacity in amperes.
4. Device Address List: Coordinate with final system programming. Floor plans shall include address numbers for all devices.
5. System Sequence of Operation: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
6. Details of graphic and alphanumeric annunciators.
7. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
8. Include half-size plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.

9. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
10. Include List of extra materials to be provided for the project.
11. Provide both paper (preferably "half-size" 15' x 22") and electronic (preferably in AutoCAD 2010 format) copies.
12. Submittal drawings must include the following:

    a. Provide floor plans with ALL device locations and their associated addresses. Floor plans must be drawn to scale.
    b. Provide a riser diagram regardless of system size.
    c. Wiring Diagrams: Provide the following:

        1) Detail wiring and differentiate between manufacturer-installed and field-installed wiring.
        2) Include diagrams for equipment and for system with all terminals and interconnections identified.
        3) Include all internal network cards and boards in FACP and Transponder Panels.

D. Qualification Data: For qualified Installer.

E. Field quality-control reports.

F. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Record copy of site-specific software.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:

    a. Frequency of testing of installed components.
    b. Frequency of inspection of installed components.
    c. Requirements and recommendations related to results of maintenance.
    d. Manufacturer's user training manuals.

5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire-alarm control unit.
7. Copy of NFPA 25.

G. Informational Submittals: Submit following:

1. Operating Instructions: For mounting at FACP.
2. Product Certificates: Signed by manufacturers of system components certifying that products furnished comply with requirements.
3. Installer Certificates: Signed by manufacturer certifying that installers comply with requirements.
4. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Comply with NFPA 72.

H. Submissions to University Fire Marshal:
1. In addition to distribution requirements for Submittals specified in the UMB General Conditions – Submittal Procedures, make identical submission to authorities having jurisdiction. Include copies of annotated Contract Drawings as needed to depict component locations to facilitate review. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Engineer for review.

I. Project Closeout Submittals: Submit the following in accordance with the UMB General Conditions.
1. Certificate of Completion: Comply with NFPA 72.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Contractor installing the system must be and/or employ a NICET level IV senior engineering technician to supervise the entire installation. In addition, the installing contractor must be a National Institute for Certification in Engineering Technologies (NICET) Level IV certified installer of fire alarm systems.

B. Installer must provide a list of five (5) previous projects done for the FAS manufacturer that are equivalent in FAS system type and scope of this project.

C. Manufacturer Qualifications: Firm experienced in manufacturing systems similar to those indicated for this Project and with record of successful in-service performance.

D. Source Limitations: Obtain fire alarm system components through one source from single manufacturer.

E. Compliance with Local Requirements: Comply with applicable building code, local ordinances and regulations, and requirements of authorities having jurisdiction.

F. Comply with NFPA 70 and 72.

G. Source Limitations for Fire-Alarm System (FAS) and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.

1. For projects involving only modifications to an existing FAS, the University will provide electronic copies to the FAS manufacturer of their latest version of the FAS As-Builts. The FAS manufacturer will make all necessary revisions to the FAS as-builts and submit them for review/approval. Once the project is completed, the FAS manufacturer will update the copies for forwarding electronically to the University for archiving. In revising the electronic copies of the University's as-builts, please perform the changes in the following format:

    a. Show all new wiring and equipment in bold so it is convenient to differentiate between new and existing.

H. 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.

I. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL.

J. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

K. NFPA Certification: Obtain certification according to NFPA 72 in the form of a placard by an FMG-approved alarm company.

L. NFPA Certification: Obtain certification according to NFPA 72.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify UMB's Representative no fewer than 10 days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with interruption of fire-alarm service without UMB's Representative written permission.

B. FIRE WATCH
Where a required existing fire protection system is out of service or during system impairment, the contractor shall provide fire watch as required by the University Fire Marshal guidelines until the existing system is repaired.
http://www.ehs.umaryland.edu/firesafety/pdf/FireWatchProcedures.pdf

1.8 WARRANTY/GUARENTEE

A. See Division 26, Specification Section "Basic Electrical Requirements" for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Existing FACU is Notifier by Honeywell.

1. Provide for the existing system, as required and as indicated on the drawings:

a. Refer to Para, 2.2 and 2.3.
b. Modifications to wiring and connections.
c. Reprogramming of control panel, addresses, etc.
d. Additional parts, modules, amplifiers, relays, etc.
e. Connections to existing supervisory and alarm devices not being replaced with new.
f. Connections for auxiliary functions, as required.
g. Extensions of signal control and power wiring, as required. SLC and/or NAC 'T' taps are strictly prohibited on both SLC and NAC loops. If this poor workmanship is discovered, it will be required to be removed.
h. Connections to new and existing components.
i. The existing devices shall be upgraded with proper addressable modules, monitoring modules, relay modules etc. and any new devices shall be provided with new modules to ensure that the system is code compliant as required by the UM Fire Marshall.
j. All existing duct smoke detectors in the building shall be replaced with new addressable type. Replace existing sampling tube and all accessories for a complete new installation.
k. Provide 3rd party interface connections to security system, halon system etc.
l. Provide all new wiring.
m. Provide interface connections for all elevator functions. If the buildings have multiple elevator controllers, provide monitor modules for each elevator.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one (1) or more of the following devices [and systems]:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.

B. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators. Record the event on system printer.

2.3 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Manual stations shall be Notifier NBG12-LX. For outdoor locations provide weatherproof manual pull stations Notifier NBG-12LOB.
2. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
3. Station Reset: Key- or wrench-operated switch.
4. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
5. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.
6. FireStopper II Weatherproof Audible Alarm Covers - Provide FireStopper II (STI-1130 for indoors and STI-1150 for outdoors) covers on all pull stations at the following locations:

    a. Building exterior exit doors.
    b. All pull stations in parking garages shall be surface mounted model STI-1155.
    c. All ground floor pull stations.
    d. All 1st floor pull stations.
    e. All pull stations located in entry/exit to crossover-bridge to neighboring buildings.

7. Provide manufacturer's optional RED back-boxes for mounting of all fire alarm pull stations.

2.4 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be two wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.

    a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15^0F or 20^0F per minute.
    b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135^0F or 155^0F.
    c. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

3. Notifier Model # FSP-851.

C. Ionization Smoke Detector:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.

2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

3. Notifier Model # FSI-851.

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

7. Notifier Model # DNR with FSP-851 HEAD.

2.5 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.

B. Heat Detectors for supervisory signal initiation, provide Notifier 302 series for the applications as indicated on the drawings. Heat Detectors for alarm signal initiation for indoor applications provide Notifier FST series.

C. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135^0F or a rate of rise that exceeds 15^0F per minute unless otherwise indicated.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.

2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

D. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 194^0F

1. Mounting: Adapter plate for outlet box mounting.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.6 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.
1. Combination Devices: Factory-integrated audible and visible devices in single-mounting assembly.

B. Audio Amplifier Output Capability: Confirm adequate amplification is built into system to support throughout the protected area/space regardless of distance from nearest audible device as well as type of audible device being provided (e.g. speaker, horn,trumpet).

C. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.

D. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol. Provide horns in mechanical rooms or where indicated on the drawing. Provide Wheelock Model #HNR.

E. Weatherproof Horn/Strobes:
1. Provide weatherproof horn/strobes with weatherproof back boxes as indicated on the drawings.

a. Audible Strobe, Wheelock # ASWP-24MCWH-FR

b. Strobes, Wheelock # AH-24WP-R

c. Back boxes for weatherproof horns/strobes, Wheelock # WPBB-R and WBB-R.

F. Beacon Lights:
1. Provide rotating beacon lights in mechanical rooms or where indicated on the drawings. Edwards # 53DR-GW with WBR mounting bracket.
2. Provide weatherproof flashing beacon lights where indicated on the drawings. Edwards # 125HALFR24A with suitable mounting bracket.

G. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.

1. Rated Light Output:

a. 15/30/75/110 CD, selectable in the field.

2. Mounting: Recessed wall mounted unless otherwise indicated. Ceiling mounted devices are not acceptable.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finished, red.
7. Provide Wheelock Exceeder Series.

H. Voice/Tone Notification Appliances:

1. Appliances shall comply with UL 1480 and shall be listed and labeled by an NRTL.

2. Speakers shall be provided for use with 70v system.
3. High-Range Units: Rated 2 to 15 W.
4. Low-Range Units: Rated 1 to 2 W.
5. Mounting: Flush. Ceiling mounted devices are not acceptable.
6. Matching Transformers: Tap range matched to acoustical environment of speaker location.
7. Provide Wheelock E50 Series Speakers/Speaker Strobes.

I. Mount all notification appliances in manufacturer’s optional red boxes.

2.7 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. Rating: 24-V ac or dc.

B. Material and Finish: Match door hardware.

2.8 WIRE

A. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 C, color-coded insulation.

1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.

B. Power-Limited Circuits: NFPA 70, Types FPL, FPLR, or FPLP, as recommended by manufacturer.
1. For use on fire alarm circuits as required.
2. Continuous red identifying stripe.
3. UL Listed Fire Alarm Cable.
4. Rated for use in plenums.
5. Rated for through penetrations of one (1), two (2), and three (3) hour fire walls.
6. Individually twisted pairs and shielding, as required per fire alarm system manufacturer.
7. Fire resistant and low smoke.
8. NEC compliant.

C. Refer to Part 3 under "Grounding and Shielding" for additional cabling/wiring requirements and their applicability for the FAS wiring provided. Confirm all shield and grounding requirements with equipment vendor prior to installing any FAS circuit wiring.

2.9 LINE-ISOLATION MODULES

A. Provide minimum one ISO-X per floor, maximum 25 devices per ISO-X.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.

B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the supervising station.
3. Expand, modify, and supplement existing control monitoring equipment as necessary to extend existing control monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

C. Smoke- or Heat-Detector Spacing:

1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed thirty (30) feet
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
5. HVAC: Locate detectors not closer than three (3) feet from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than twelve (12) inches from any part of a lighting fixture.
7. Wall-Mounted Smoke Detectors: At least four (4) inches, but not more than twelve (12) inches, below ceiling.

D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

E. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

F. Audible Alarm-Indicating Devices: Install not less than six (6) inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

G. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.

H. Device Location-Indicating Lights: Locate in public space near the device they monitor.

I. Manual Pull Stations: Mount flush or semi-flush in recessed back boxes where possible.

3.2 CONNECTIONS

A. For each tamper, flow and pressure switch on the sprinkler system, provide a dedicated address point. DO NOT “DAISY CHAIN” OR “PARALLEL” tamper, flow or pressure switch to a common addressing point or monitoring module.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

C. Identify all FAS boxes, outlets, raceway, cabling and wiring as the following requirements. Provide additional labeling as indicated on contract drawings.

D. SLC Loop Devices: Label all SLC loop devices to note the device address and purpose.

E. Where EOL resisters have been installed for SLC or NAC circuits at device/junction box, panel etc., provide label, “EOL RESISTER__OHMS SLC OR NAC CIRCUIT #.

F. Fire Alarm System Conduits and Cabling: Label all FAS raceway/conduit at every floor for vertical runs; at each penetration to a junction box, transponder panel, security panel, etc.; every 10 to 15 feet in concealed accessible areas (horizontal runs) and every 25 feet in exposed areas (horizontal runs) per UM A/E Standards. Wording for the FAS Raceway and Cabling shall be as follows:
   1. FAS Device Loop: to read "FAS Notification and Signal Appliance Loop XX Floor – XX/0."

G. Fire Alarm System Cabling Installed Exposed in Concealed Ceilings without Being in Raceway: Verbiage and Spacing of labeling shall be as stated above except labels shall be attached directly to cable jackets. Maximum length of label is not important.

H. Fire Alarm System Junction Boxes and Outlets Including Relay Modules: All fire alarm system junction boxes, outlets and covers shall be : “RED” in color and labeled as per the following:

   1. Junction Boxes: Same as raceway serving the junction box. Otherwise, to read "Fire Alarm System – XX/0."

I. HVAC System 'FRM-1' Relay Duct Smoke Detector 'Shutdown Requests': Label each 'FRM-1' relay located at the ATC Panel(s) to identify its' address, purpose, and the individual HVAC System that it controls. For example, "HVAC System No. ___ Duct Smoke Detector Shutdown" - Address 62-51.

J. Duct Smoke Detector Remote LED's: Label each remote LED to identify the detectors device address as well as the HVAC system it is associated with.

3.4 WIRING INSTALLATION

A. Wiring Method:
   1. Install wiring in metal raceway according to Section 260533 unless otherwise directed on the contract drawings - Raceways and Boxes. Conceal raceway except in unfinished spaces and as indicated. DO NOT install fire alarm conduits in slabs.

B. Wiring within Enclosures: Separate class 1 power-limited and class 2/class 3 non-power-limited conductors as recommended by manufacturer. Provide terminations of class 1 power-limited and class 2/class 3 non-power-limited conductors in all system components as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Wire Nuts, Straight Connectors, Terminal Strips, etc.: The use of wire nuts, straight connectors, terminal strips, etc. for cable splicing is absolutely prohibited. Pull new cable to the nearest upstream and downstream devices when adding new devices to an existing SLC and/or NAC. If this poor workmanship is discovered, it will be required to be removed.

D. SLC and/or NAC 'T' Taps: 'T' taps are strictly prohibited on both SLC and NAC loops. If this poor workmanship is discovered, it will be required to be removed.

E. Color-Coding: Color-code fire alarm conductors differently from normal building power wiring. Use one color-code for alarm circuit wiring and different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices.

3.5 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground cable shields and equipment according to system manufacturer's written instructions to eliminate shock hazard and to minimize, to greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. Specific Shielding and Grounding Requirements: Unless directed otherwise by the equipment vendor, provide circuit shielding and grounding as per the following:

1. All circuits except for speaker circuits must be shielded.
2. All circuit shields must be continuous at the field devices and only be grounded at the point of origin (i.e. the FACP or remote transponder panel).
3. All Backbone Network Loop wiring must be shielded with the shields tied together at each drop (i.e. the transponder panels) and grounded at the FACP.
4. Addressable Relays: All addressable relay module circuit boards must be grounded (unless otherwise instructed by vendor) and their shield wires continuous OR the boards not grounded and the shield wiring be used as the grounding conductor.

5. Where FAS circuits are run in non-metallic raceway, the above requirements must be followed to ensure adequate grounding and shield protection is provided.

D. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.

E. Install grounding electrodes of type, size, location, and quantity as indicated. Comply with installation requirements in Section 260526 – Grounding and Bonding.

F. Ground equipment and conductor and cable shields. For audio circuits, minimize, to greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

G. Ground radio alarm transmitter system and equipment as recommended by manufacturer.

3.6 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.

a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

E. Fire-alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Contractor Pretesting: After installation, align, adjust, and balance system and perform complete pretesting. Determine, through pretesting, compliance of system with

requirements of Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones, and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

H. Final acceptance testing with the UM Fire Marshall: After installation, align, adjust, and balance system and perform complete pretesting with the University Fire Marshall. Determine, through pretesting, compliance of system with requirements of Drawings and Specifications. After pretesting is completed, correct deficiencies observed in pretesting for final testing. Replace malfunctioning or damaged items with new ones, and retest until satisfactory performance and conditions are achieved. Remove existing devices after pretesting has been completed with the UM Fire Marshall.

I. Final acceptance testing: After final acceptance testing is complete, provide letter certifying installation is complete and fully operable, including names and titles of witnesses to preliminary tests.

J. Final Test Notice: Provide minimum of ten (10) days' notice in writing when system is ready for final acceptance testing.

K. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by system test that total system meets Specifications and complies with applicable standards.

3.7 CLEANING AND ADJUSTING

A. Cleaning: Comply with Section 01740. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

3.8 REPAIRS & RESTORATION OF SURFACES AND FINISHES:

A. Restore all finishes, equipment and surfaces to original condition, where affected by the work. Provide the following, where applicable, in accordance with accepted trade standards and to Owner’s satisfaction:

1. Replace damaged ceiling tiles.
2. Replace ceiling tiles where removal has left holes or cuts in original tiles.
3. Patch, repair and repaint all walls and surfaces cut, penetrated or otherwise disturbed by the work.
4. Patch holes and penetrations in wood, masonry and plaster.
5. Provide suitable cover plates for all recessed back boxes of equipment removed and not covered by new devices.
6. Provide larger trim or cover plates for new devices, where old back boxes, holes,

etc. are not concealed by new work.

3.9 PROGRAMMING

A. Prior to programming of the fire alarm system, the contractor shall contact UMB project manager to obtain available nodes.

END OF SECTION 283111

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