UNIVERSITY of MARYLAND
BALTIMORE

ADMINISTRATION & FINANCE

DESIGN AND CONSTRUCTION

SPECIFICATIONS FOR THE BRESSLER RESEARCH BUILDING SUBSTATIONS 4-7 RENEWAL AT THE UNIVERSITY OF MARYLAND

UNIVERSITY PROJECT # 19-312
BUILDING INVENTORY No. 8050

CONSTRUCTION DOCUMENTS

PROJECT SPECFICATIONS

December 18, 2020 Office of Facilities Management Design and Construction

---

Owner
University of Maryland, Baltimore
Design and Construction
Office of Facilities Management
620 W. Lexington Street, 6th Floor
Baltimore, Maryland 21201

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

Maryland General Assembly
William C. Ferguson, Senate President
Adrienne A. Jones, House Speak

Architect
Marshall Craft Associates, Inc.
2031 Clipper Park Road
Baltimore, MD 21211

MEP Engineer
WFT Engineering
1801 Research Blvd., Suite 100
Rockville, MD 20850

Structural Engineer
Carroll Engineering
215 Schilling Circle, Suite 102
Hunt Valley, MD 21031

UMB MASTER SPECIFICATIONS TABLE OF CONTENTS

DIVISION 07: THERMAL AND MOISTURE PROTECTION

DIVISION 08: OPENINGS

DIVISION 09: FINISHES

DIVISION 21 FIRE PROTECTION

DIVISION 23 HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

DIVISION 26: ELECTRICAL

SECTION 010100 - 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 the replacement of penthouse substations 4 through 7 with new, the provision of a UPS for the BAS system, and associated feeders and controls.

1. Project Location: 655 WEST BALTIMORE ST, BALTIMORE, MD 21201

2. Owner: University of Maryland, Baltimore.

B. Contract Documents, dated December 18, 2020 were prepared for the Project by

Architect
Marshall Craft Associates, Inc.
2031 Clipper Park Road
Baltimore, MD 21211

MEP Engineer
WFT Engineering
1801 Research Blvd., Suite 100
Rockville, MD 20850

Structural Engineer
Carroll Engineering
215 Schilling Circle, Suite 102
Hunt Valley, MD 21031

C. The Work consists of the renewal of Substations 4-7 in the penthouse of the BRB.

1.3 WORK SEQUENCE

A. The following description is a proposed sequence of work. Contractor to confirm the feasibility of proposed sequence and submit CPM schedule as described in section 013100 SCHEDULES AND REPORTS for review.

B. Phasing description.

1. Phase One: Clearing Space for the New Electrical Switchgear
   - Demolish existing roof hatch and provide new hatch.
   - Install a new 600amp MLO,480, 3Ø,3w Motor Control Center PB (MCC-PB) on southeast wall near substation 7. Provide temporary incoming 3P, 600amp power feed from spare switch in existing Substation 7.
   - After new power to MCC-PB is active, provide new pull box(es) in accessible ceiling space outside of the boundary area of the new electrical room and provide new conduits and circuits from new "MCC-PB" to pull box(es).
   - Start turning off power and disconnect each existing circuit and rerouting them from existing MCC-PB, MCC-PD and EF-63 VFD equipment to pull box and splice to existing circuits
   - Relocate existing EF-63 VFD equipment to the southeast wall near substation 7. Provide new conduit and circuit from EF-63 VFD new location to pull box and slice existing circuit.
   - Turn off existing MCC-PB main power switch in Substation 6, MCC-PD main power switch in Substation 7 and remove existing incoming electrical feeders and conduits in its entirety. Both MCC-PB and MCC-PD equipment to be removed and discarded.
   - Pour new housekeeping pad for new preaction cabinet and nitrogen generator. Relocate existing combination standpipe riser, NFPA 14 Class I 2-1/2" hose outlet, and 6" zone control for Penthouse overhead wet sprinkler system.
   - Pipe new preaction cabinet feed downstream of new zone control and rough-in new preaction cabinet.
   - Wire and confidence test all fire alarm devices associated with fire sprinkler monitoring to ensure fire protection is maintained in service.

2. Phase Two: Installation of New Substations
   - Install new concrete pad in the proposed location of new Substations "A" and "B".
   - Install the new mounted double ended Substations 'A' and 'B'. Run a cat6 cable to each switchboard (and daisy-chain the 2 meters in a double-ended board). Run cat 6 cable in 1" from each meter to building network switch located in the penthouse.
   - Provide core drill in floor and install 2-3" conduit from HV pull box in basement Electrical Room B027 stubbed up into penthouse.
   - Install HV linear pull box on penthouse wall space and intercept the 2-3" conduit riser.
   - Install 2- 3" conduits from new Substations "A" and "B" to HV pull box in penthouse.
   - Install new feeders from basement Electrical Room B027 to new Substations "A" and "B" in penthouse.

3. Phase Three: Basement work

- Open and close switches NE3 and NW3 in the existing penthouse substations 4, 5, 6, and 7 such that all substations are being powered by a single incoming feeder.
- While the single incoming feeder is providing power the existing penthouse substations. Disconnect power to the other main switch and splice onto one of the new feeder cables in pull box to feed power to the new Substation "A" and "B" in penthouse.

4. Phase Four: Removal of Existing Substation 7
   - Provide a new 1200amp, MLO, 480/277v,3Ø,4w Main Distribution Panel MDP7.
   - Provide incoming feeders and conduits from Substation "B" to new Panel MDP7.
   - After Panel MDP7 is powered and active; rerouted temporary incoming feed to MCC-PB from existing Substation 7 to new Panel MDP7 (6-hour shutdown).
   - Provide a pull box in accessible ceiling space and provide new circuits and conduit from new Panel MDP7 to pull box. Turn off power and disconnect each existing circuit and rerouting them from existing Substation 7 to new pull box and splice to new circuits (12-hour shutdown).
   - After all existing circuit have been routed to Panel MDP7 and are active. Open incoming power switch at Substation 6 that feeds Substation 7 and remove the existing feeder and conduit connection in its entirety.
   - Remove existing Substation 7 in its entirety. Equipment shall be discarded.

5. Phase Five: Removal of Existing Substation 6
   - Provide a new 1600amp, MLO,480/277v,3Ø,4w Main Distribution Panel MDP6.
   - Provide incoming feeders and conduits from Substation "B" to new Panel MDP6.
   - After Panel MDP6 is powered and active; provide a pull box in accessible ceiling space and provide new circuits and conduit from new Panel MDP6 to pull box. Turn off power and disconnect each existing circuit and rerouting them from existing Substation 6 to new pull box and splice to new circuits. (12-hour shutdown)
   - After all existing circuit have been routed to Panel MDP6 and are active. Open incoming power switch at Substation 5 that feeds Substation 6 and remove the existing feeder and conduit connection in its entirety.
   - Remove existing Substation 6 in its entirety. Equipment shall be discarded.

6. Phase Six: Removal of Existing Substation 5
   - Provide a new 1200amp, MLO,480/277v,3Ø,4w Main Distribution Panel MDP5.

- Provide incoming feeders and conduits from Substation "A" to new Panel MDP5.
- After Panel MDP5 is powered and active; provide a pull box in accessible ceiling space and provide new circuits and conduit from new Panel MDP5 to pull box. Turn off power and disconnect each existing circuit and rerouting them from existing Substation 5 to new pull box and splice to new circuits. (12-hour shutdown)
- After all existing circuit have been routed to Panel MDP5 and are active. Open incoming power switch at Substation 4 that feeds Substation 4 and remove the existing feeder and conduit connection in its entirety.
- Remove existing Substation 5 in its entirety. Equipment shall be discarded.
- Remove all the existing lighting fixtures within the new electrical room boundary.
- Construct walls and ceiling around Electrical Room PH-001A.
- Relocate existing Panel DPL-PJ1, Receptacles, Mechanical Fan controls to furred out wall for the new electrical room.
- Install fire alarm, fire sprinkler, and lighting fixtures in enclosed Electrical Room PH-001A.

7. Phase Seven: Removal of Existing Substation 4
   - Provide a new 1200amp, MLO, 480/277v,3Ø,4w Main Distribution Panel MDP4.
   - Provide incoming feeders and conduits from Substation "A" to new Panel MDP4.
   - After Panel MDP4 is powered and active; provide a pull box in accessible ceiling space and provide new circuits and conduit from new Panel MDP4 to pull box. Turn off power and disconnect each existing circuit and rerouting them from existing Substation 4 to new pull box and splice to new circuits. (12-hour shutdown)
   - After all existing circuit have been routed to Panel MDP4 and are active. Open incoming switch in basement main electrical room that feeds Substation 4 and remove the existing feeder and conduit.
   - Remove existing Substation 4 in its entirety. Equipment shall be discarded.
   - Install all HVAC equipment.
   - Install fire sprinklers under new ducts greater than 48in wide.

1.4 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.

1.5 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.

B. Partial University Occupancy: The University reserves the right to occupy and to place and install equipment in completed areas of the building prior to Substantial Completion, provided such occupancy does not interfere with completion of the Work. Such placing of equipment and partial occupancy shall not constitute acceptance of the total Work.

1. The University will conduct a punchout of the area to be occupied and prepare a punchlist. If it is determined that the work is substantially complete, the University will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior to University occupancy. A blank Certificate of Substantial completion is included at the end of this section.
2. Prior to partial University occupancy, mechanical and electrical systems shall be fully operational. Required inspections and tests shall have been successfully completed. Upon occupancy, the University will operate and maintain mechanical and electrical systems serving occupied portions of the building.
3. Upon occupancy, the University will assume responsibility for maintenance and custodial service for occupied portions of the building.

1.6 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 (No Applicable)

END OF SECTION 010100

SECTION 010270 - 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 010350 - 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. Sample copies are included at the end of this Section.

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)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01035

SECTION 010400 - 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. Excessively high or low temperatures.
4. Thermal shock.
5. Excessively high or low humidity.
6. Air contamination or pollution.
7. Water or ice.
8. Solvents.
9. Chemicals.
10. Light.
11. Radiation.
12. Puncture.
13. Abrasion.
14. Heavy traffic.
15. Soiling, staining, and corrosion.
16. Bacteria.
17. Rodent and insect infestation.
18. Combustion.
19. Electrical current.
20. High-speed operation.
21. Improper lubrication.

22. Unusual wear or other misuse.
23. Contact between incompatible materials.
24. Destructive testing.
25. Misalignment.
26. Excessive weathering.
27. Unprotected storage.
28. Improper shipping or handling.
29. Theft.
30. Vandalism.

END OF SECTION 01040

SECTION 010450 - 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the 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. (See attached).

2. Obtain approval of the cutting and patching proposal before cutting and patching the following structural elements:
   a. Bearing and retaining walls.
   b. Structural concrete.
   c. Structural steel.
   d. Lintels.
   e. Structural decking.
   f. Stair systems.
   g. Miscellaneous structural metals.
   h. Exterior curtain-wall construction.
   i. Equipment supports.
   j. Piping, ductwork, vessels, and equipment.

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. Electrical wiring systems.
   j. Fire rated assemblies.

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. Processed concrete finishes.
   a. Clay masonry.
   b. Ornamental metal.
   c. Preformed metal panels.

d. Firestopping.
e. Window wall system.
f. Acoustical ceilings.
g. HVAC enclosures, cabinets, or covers.

D. Cutting and Patching Responsibilities:

1. Cutting: cutting shall be the work of the trade requiring the cutting for access, or for permitting the alteration to be performed or an approved subcontractor designated by the trade or the CM.
   a. Cutting required for inspections shall be the work of the CM/GC.
   b. Cutting required to obtain test samples of suspected hazardous materials shall be the work of a contractor licensed for the removal of hazardous materials.
2. Patching: Patching shall be the work of the appropriate trade.
   a. Maintain the rating of fire rated barriers, using approved sealant products.
3. Fire Rated Barriers: Where existing fire rated barriers, located in the project area, have unsealed openings for mechanical and electrical work, these openings shall be sealed using the approved sealant products to maintain the fire rating of the barrier.

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. For building exterior or visible interior elements, the Architect and the UMB representative must approve substitutions. 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 CONSTRUCTION WORK – EXCESSIVE NOISE

A. All construction work that creates excessive noise will not be permitted during normal business hours, 8:00am to 5:00pm (M-F) or 8:00am to 8:00pm (weekends). Work such as

core drilling floors, cutting masonry construction or other materials, or inserting hangers in floor slabs shall be scheduled between 5:00am and 8:00am (M-F) or 10:00pm to 8:00am (weekends). Coordinate actual time frames with UMB – Project Manager.

3.2 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.

1. Before proceeding, meet at the Project Site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

3.3 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.

3.4 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.

3.5 PAINTING

A. Extent of Painting:
1. Paint over the entire surface plane, unless otherwise noted.
2. Over patched surfaces paint to the nearest cut off line for the entire surface, such as the intersection with adjacent wall, ceiling, beam, bulkhead, or to the nearest opening frame where a total cut off does not occur within ten (10) feet of the patch, unless otherwise noted.

B. Appearance and Finish:
   1. Appearance: Ensure painted surfaces do not present a spotty, touched-up appearance.
   2. Finish: Provide a smooth continuous surface in texture, coverage and color.

3.6 CLEANING

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

SECTION 010950 - 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.
3. Assigning Specialists: Certain Sections of the Specifications require that specific construction activities shall be performed by specialists who are recognized experts in those operations. The specialists must be engaged for those activities, and their assignments are requirements over which the Contractor has no option. However, the ultimate responsibility for fulfilling contract requirements remains with the Contractor.
    a. This requirement shall not be interpreted to conflict with enforcing building codes and similar regulations governing the Work. It is also not intended to interfere with local trade-union jurisdictional settlements and similar conventions.

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 SPECIFICATION FORMAT AND CONTENT EXPLANATION

A. Specification Format: These Specifications are organized into Divisions and Sections based on CSI's 16-Division format and UMB’s Master format numbering system.

B. Specification Content: This Specification uses certain conventions regarding the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations or circumstances. These conventions are explained as follows:

1. Abbreviated Language: Language used in Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be interpolated as the sense requires. Singular words will be interpreted as plural and plural words interpreted as singular where applicable as the context of the Contract Documents indicates.

2. Streamlined Language: The Specifications generally use the imperative mood and streamlined language. Requirements expressed in the imperative mood are to be performed by the Contractor. At certain locations in the Text, subjective language is used for clarity to describe responsibilities that must be fulfilled indirectly by the Contractor or by others when so noted.
   a. The words "shall be" are implied where a colon (:) is used within a sentence or phrase.

1.4 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.

1.5 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

SECTION 012000 - 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.
3. Coordination 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.

1.5 COORDINATION MEETINGS

A. Conduct project coordination meetings at regular intervals convenient for all parties involved. Project coordination meetings are in addition to specific meetings held for other purposes, such as regular progress meetings.

B. Request representation at each meeting by every party currently involved in coordination or planning for the construction activities involved.

C. Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

D. Review the progress of other construction activities and preparations for the particular activity under consideration at each preinstallation conference, including requirements for the following:

1. Contract Documents.
2. Options.
3. Related Change Orders.
4. Purchases.
5. Deliveries.
6. Shop Drawings, Product Data, and quality-control samples.
7. Review of mockups.
8. Possible conflicts.
9. Compatibility problems.
10. Time schedules.
11. Weather limitations.

12. Manufacturer's recommendations.
13. Warranty requirements.
14. Compatibility of materials.
15. Acceptability of substrates.
16. Temporary facilities.
17. Space and access limitations.
18. Governing regulations.
19. Safety.
20. Inspecting and testing requirements.
21. Required performance results.
22. Recording requirements.
23. Protection.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01200

SECTION 012300 - ALTERNATES

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. Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

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

1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.

2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternates into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

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

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

B. Execute accepted alternates under the same conditions as other Work of the Contract.

C. Schedule: A Part 3 "Schedule of Alternates" Article is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

D.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Alternate No.1: Additional Core Drills

1. Base Bid: Provide new 3”-conduits shown on drawings E101 and E102 in existing sleeves through floor slabs.

2. Alternate: Provide new 3”-conduits shown on drawings E101 and E102 in new core drills from Penthouse to Basement.

END OF SECTION 012300

SECTION 013000 – SUBMITTAL PROCEDURES

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.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for submittals by the Contractor as required by the contract documents.

1.3 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

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

C. Closeout Submittals: Written and graphic information regarding the operations and maintenance of a product or system, and that do not require Architect's responsive action. Closeout submittals are those submittals indicated in individual Specification Sections as "closeout submittals." Closeout Submittal will be acknowledged.

D. Shop Drawings, Product Data and Samples: Instruments prepared and submitted by Contractor, for Contractor’s benefit, to communicate to Architect the Contractor’s understanding of the design intent, for review and comment by Architect on the conformance of the submitted information to the general intent of the design. Shop drawings, product data and samples are not Contract documents. Drawings, diagrams, schedules and illustrations, with related notes, are specially prepared for the Work of the Contract, to illustrate a portion of the Work.

E. Product Data: Standard published information (“catalog cut sheets”) and specially prepared data for the Work of the Contract, including standard illustrations, schedules, brochures, diagrams, performance charts, instructions and other information to illustrate a portion of the work.

F. Samples: Physical examples that demonstrate the materials, finishes, features, workmanship or and other characteristics of a portion of the Work. Accepted samples shall service as quality basis for evaluation the Work.

G. Other Submittals: Technical data, test reports, calculations, surveys, certifications, special warranties and guarantees, operation and maintenance data, extra stock and other submitted information and products shall also not be considered Contract Documents but shall be information from Contractor to Architect to illustrate a portion of the Work for confirmation of understanding the design intent.

H. e-Builder: The University employs the e-Builder Construction Project Management System. The software enables members to manage work via a web based graphical interface. Owner will establish project specific page on e-Builder with project specific members. The site login address is https://app.e-builder.net/.

I. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

J. XLS: A file format created by Microsoft for use with Microsoft Excel which is a spreadsheet program that presents table of values arranged in rows and columns.

1.4 SUBMITTAL SCHEDULE

A. Submittal Schedule: Contractor shall prepare and submit a Submittal Schedule which lists submittal items per the product specifications for review and approval by the Architect. Contractor shall allow seven (7) days for Architect and University review. The Submittal Schedule shall identify all specified submittals to be made and shall serve as a checklist for submittals. Arrange the submittals in numerical order by specification section. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.

1. Use the Preliminary Project Submittal Register (when provided by the Architect) as a basis for submittals required to be submitted, including requirements for concurrent submittals, and complex submittals which may require additional review time by the Architect at Initial Review.
2. Coordinate Submittal Schedule with list of subcontracts, the Schedule of Values, and Contractor's construction schedule.
3. Format: Submit the Submittal Schedule as a Microsoft Excel file. Use the University-provided excel template which can be found in the eBuilder submittal folder.
4. The first submittal shall be the Submittal Schedule.

5. Review of any submittal without submission and approval of submittal schedule does not relieve Contractor of responsibility to provide Submittal Schedule for approval.

1.5 SUBMITTAL FORMATS

A. Assemble all Action Submittals for each specification section into a single Submittal Package for delivery to Architect unless otherwise specified or agreed to during the Submittal Schedule review. Failure of Contractor to assemble all Action Submittals in single package may result in Architect withholding action on submittal(s) until associated submittal(s) required by applicable specification section are received.

1. Submit Product Data (as a separate Submittal Item) before or concurrent with Shop Drawings and before or concurrent with Samples.
2. Informational or Closeout Submittals, or Submittals for Work Performed by Separated Trades: Submit in separate Submittal Package as applicable rather than in single Action Submittal package described above.
3. Submittals shall be processed electronically using e-Builder. Transmit all submittals from Contractor to Architect via e-Builder, unless otherwise directed. Submittals received from sources other than the Contractor will be returned without action. Include all information specified below for identification of submittals.

1.6 SUBMITTAL IDENTIFICATION FORM

A. Submit each Submittal Item with a Submittal Identification Form, in a format developed with the Architect and acceptable to the University, including the following information for each submittal:

1. Project name and University project number.
2. Submission date.
3. Name and address of Architect.
4. Name and address of Contractor.
5. Name of firm or entity that prepared submittal.
6. Names of subcontractor, manufacturer, and supplier as applicable.
7. Category (action or informational).
8. Include the following information identical to that listed in the approved Submittal Schedule.

    a. Specification section.
    b. Unique submittal title, including revision identifier.

1) As an option, when a submittal item includes multiple types of submittals (Product Data, Shop Drawings, Qualifications, etc.) include an abbreviation of each that identifies the types.

c. Type of submittal (product data, test report, etc.).

1) Only one type of submittal may be selected in the drop down category, for multiple types of items in one submittal choose the category that is the most explanatory.

9. Place for Contractor submittal approval certification, including name, date and signature.
10. Identifiable location for Architect's Action stamp and/or comments.
11. Identifiable location for University's Review stamp and/or comments.
12. Other necessary identification.
13. Submittals not including a Submittal Identification Form will be returned as "Not Reviewed".

B. Identify each element in a Submittal Item by a unique identifier such as: reference to the Specifications article and paragraph, bullet, Drawing sheet number, detail, schedule, room number, assembly or equipment number, and or any other pertinent information that can be used to clearly correlate submittal with Contract Drawings.

C. On the Submittal Identification Form, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information submitted complies with requirement of the Contract Document.

D. Input each Submittal Item using the eBuilder Submittal Module with identical information as found on the approved Submittal Schedule.

E. PDF Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. For full version specifications Name PDF file with the specification section number and title. For condensed specifications Name PDF file with the specification section article number and title. Submittal file names shall be identical to that found in the approved Submittal Schedule. Provide revision number where applicable. See examples below:

1. File Name Examples:
   a. Full Version Specification: 087100 Door Hardware
   b. Condensed Specification: 220000 -2.6 Plumbing Valves
   c. Condensed Specification: 220000 -2.6 Plumbing Valves R1

2. Contractor's file names shall not be altered by the A/E and UMB except adding the A/E and UMB Initials (XXX) at each review step. See examples below:

a. Full Version Specification: 087100 Door Hardware.pdf
b. Full Version Specification: 087100 Door Hardware XXX.pdf
c. Condensed Specification: 220000 -2.6 Plumbing Valves.pdf
d. Condensed Specification: 220000 -2.6 Plumbing Valves XXX.pdf

F. Options: Identify options requiring selection by Architect.

1.7 SUBMITTAL PROCEDURES

A. Prepare and submit submittals required by individual Specification Section. Types of Submittal Items are indicated in individual Specification Section.

B. Submittal Item: Each submittal Item shall be provided with a Submittal Identification Form addressed from the Contractor to the Architect.

C. Submittal Packages: Each Submittal Item, as an option, may be categorized into a numbered Submittal Package. Identify the Submittal Package number on the Submittal Identification Form. Submittal Package may include submittals from multiple specification sections if concurrent submission is required by the Architect.

D. Use the eBuilder Submittal Module to create each Submittal Item. Persons entering submittals shall be trained by UMB on the eBuilder Submittal Module prior to entering the Submittal Schedule and any other submittals. Upload the pdf of the submittal directly to the e-Builder Submittal Module.

E. Submitted file shall be a searchable PDF electronic file.

F. Use bookmarks, for files larger than 15 pages, indicating all items within the document. Provide breakout into subsections as needed for easy access. Hyperlinks within the document can be used in addition, but not as a replacement for bookmarks. Hyperlinks to documents on the web are not allowed.

G. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.

4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections so processing will not be delayed because of need to review submittals concurrently for coordination.

    a. Certain submittals need to be reviewed concurrently, including but not limited to, the following:
        1) Fire Protection Product Data, Hydraulic Calculations, and Layout Shop Drawings.
        2) Wall and floor finishes for coordination of colors.

            a) Submittals that require selection of colors will be reviewed. Color selection may not be provided until all submittals requiring color selection have been received and reviewed, and color selections have been approved by the Architect.

    b. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals, as identified in paragraph D.4.a above, until related submittals are received.

H. Processing Time: Allow time for submittal review, including time for resubmittals, as follows: Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the work to permit processing, including resubmittals.

1. Initial Review: Allow 15 working days for initial review of each submittal (which includes University's review) unless otherwise noted on the approved Submittal Schedule. Allow additional time if coordination with concurrent submittals is required. The Architect will advise Contractor when a submittal being processed must be delayed for coordination.
2. Initial Review of Concurrent Submittals: Allow additional time if coordination with concurrent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
3. Initial Review of Complex Submittals: At the time of review and approval of the Submittal Schedule, the Architect will advise Contractor of certain submittals that are substantially complicated or require multiple reviewers and need an extended initial review time, including but not limited to, the following:

    a. 081113 Hollow Metal Doors and Frames (21 days)
    b. 087100 Door Hardware (21 days).
    c. 211313 Fire Protection Sprinkler and Standpipe Systems (45 days) includes Fire Marshal review.
    d. 283111 Addressable Fire-Alarm System (45 days) includes Fire Marshal review.

4. Resubmittal Review: Allow 15 days for review of each resubmittal.

I. Resubmittals: Make resubmittals in same form as initial submittal.

1. Note date and content of previous submittal only (do not include entire rejected submittal).
2. Note date and content of revision in Submittal Identification Form and clearly indicate extent of revision. Provide responses to Architect's review comments as appropriate to address concerns raised. Annotate the product data sheets, shop drawings, calculations, etc. to clearly indicate compliance with the original specification requirements and to demonstrate compliance with review comments.
3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.

J. Delegated Design Services Certification: In addition to other required submittals, submit digitally-signed PDF electronic file paper copies of certificate, signed and sealed by the responsible design professional.

K. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities.

L. Use for Construction: Establish and maintain access to eBuilder so that all submittals are available for use on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

1.8 CONTRACTOR'S REVIEW OF SUBMITTALS

A. Contractor's Review of Submittals: Prior to submission to Architect for review, Contractor shall collect complete submittal documentation from the Sub/Manufacturer, create the Submittal Package, and assign Submittal Items to it. Each Submittal Item shall be reviewed by the Contractor.

B. The Contractor shall create one Submittal Identification Form for each Submittal Item. The Contractor shall certify that submittals have been reviewed and approved. Note corrections and field dimensions. Mark each Submittal Item with a uniform approval stamp including the name of the reviewer and the date of the Contractor's approval and sign each Submittal Item. Submittals without stamp and signature will not be reviewed and will be returned. Electronic signatures are acceptable. Contractor's submittal approval shall certify the following actions by Contractor:

1. Field measurements have been determined and verified.
2. Conformance with requirements of Contract Drawings and Specification is confirmed.
3. Catalog numbers and similar data are correct and indicated with arrow or highlighting; items not used, but on same page shall be crossed out.
4. Work being performed by various subcontractors and trades is coordinated.

5. Field construction criteria have been verified, including confirmation that information submitted has been coordinated with the work being performed by others for the University and actual site conditions.
6. All deviations from requirements of Drawings and Specifications have been identified and noted.
7. All notes and dimensions by Contractor shall be in the color green.
8. Submittals not certified by being stamped and signed by Contractor electronically on the Submittal Identification Form will be returned without action, as will submittals which, in the Architect's opinion, have not been adequately reviewed and coordinated by Contractor.

C. Changes in Work: Changes in the Work shall not be authorized by submittal review actions. No review action, implicit or explicit, shall be interpreted to authorize changes in the Work. Changes shall only be authorized by separate written direction from the University, in accordance with the Contract General Conditions. However, to minimize the ordering of incorrect equipment/parts, notes may indicate forthcoming changes via CDC.

1.9 REVIEW OF SUBMITTALS BY ARCHITECT AND UNIVERSITY

A. Review of Submittals by Architect and University: Submittals shall be a communication aid between Contractor and Architect by which interpretation of Contract Documents requirements may be confirmed in advance of construction.

1. Reviews by University, Architect and Architect's consultants shall be only for general conformance with the design concept of the Project and general compliance with the information given in the Drawings and Specifications.
2. The Architect's review shall not be construed as an "approval," or to relieve the Contractor(s) and material suppliers of responsibility for errors or omissions in the submitted documents.
3. Acceptance of a specific item does not include acceptance of the assembly of which the item is a component.
4. Except for submittals for record, information or similar purposes, where action and return is required or requested, the Architect will review each submittal, mark to indicate action taken, and return promptly via the web-based software (e-Builder) system.

B. Architect's Review Action: Architect will mark each submittal with a uniform, self-explanatory action. Architect's action may be a stamp on the Contractor's Submittal Identification Form or a separate review sheet on Architect's standard form.

The below listing of submittal actions are the University standard stamp action and the abbreviation/notation for eBuilder. If A/E's stamp abbreviation/notations differ provide the equivalent in space provided below each paragraph.

1. Submittal will be appropriately marked as follows to indicate the action taken:

    a. Action 1 App (no exceptions taken) Means fabrication, manufacture, or construction may proceed providing submittal complies with Contract Documents.

        1) Equivalent to Architect's stamp Action "APPROVED".

    b. Action 2a AAN (note markings; no resubmission required): Means fabrication, manufacture, or construction may proceed providing submittal complies with Architect's notations and Contract Documents. (Note: If Contractor cannot comply with notations, make revisions and resubmit.)

        1) Equivalent to Architect's stamp Action "APPROVED AS CORRECTED".

    c. Action 2b RFR (note markings/resubmit for record): Means fabrication, manufacture, or construction may proceed; however, submittal did not fully demonstrate full extent of all conditions, details and coordination with other surrounding work and therefore requires additional information and rework as noted. Resubmit shop drawings for final Action 1 or 2. Should Contractor proceed with fabrication, manufacturing or construction, it shall do so at its own risk.

        1) Equivalent to Architect's stamp Action "APPROVED AS CORRECTED; RESUBMIT FOR RECORD".

    d. Action 3 A&R (revise and resubmit): Means submittal does not comply with design intent of Contract Documents. Do not use submittals stamped Action 4. Make revisions and resubmit.

        1) Equivalent to Architect's stamp Action "REVISE AND RESUBMIT".

    e. Action 5 REJ (rejected, submit specified item or resubmit with related assembly items): Means submittal varies from specified item or system specified in Contract Documents and is not acceptable for use on the project. Do not use submittals stamped Action 5. Make revisions and resubmit.

        1) Equivalent to Architect's stamp Action "NOT APPROVED".

    f. Action 6 NAR (no action required): Means documents have not been reviewed by Architect and submittal is returned to Contractor for several possible reasons: submittal not requested, submittal not complete,

Submittal Transmittal form is not included, submittal not coordinated, or submittal bears no resemblance to design intent.

1) Equivalent to Architect's stamp Action "NO ACTION REQUIRED".

2. Do not permit submittals marked "Rejected or Revise and Resubmit" to be used at the Project site, or elsewhere where Work is in progress.
3. Any work performed prior to receiving a fully approved submittal shall be done at the Contractor's risk and shall be subject to being replaced if Contract requirements are not met.

C. University Review: The University will review the submittal, stamp, and upload the stamped submittal to e-Builder.

D. Final Review Action: The Architect will provide final Action for the submittal and return stamped submittal to the Contractor.

E. Contractor Action: The Contractor will be notified through eBuilder that the submittal is ready for his action. The Contractor shall incorporate all review comments and resubmit if so indicated by the eBuilder and Architect's actions and markings.

F. Contract Requirements:

1. Review actions by Architect and Architect's consultants shall not relieve the Contractor from compliance with requirements of the Contract Drawings and Specifications.
2. Acceptance of submittals with deviations shall not relieve Contractor from responsibility for additional costs of changes required to accommodate such deviations.
3. Deviations included in submittals without prior acceptance will be considered an exception from review of submittals whether noted or not on returned copy.
4. No review action, implicit or explicit, shall be interpreted to authorize changes in the Work. Changes shall only be authorized by separate written Change Order or Field Instruction, in accordance with the Contract General Conditions.
5. When professional certification of performance criteria of materials, systems or equipment is required by Contract Documents, the Architect shall be entitled to rely upon accuracy and completeness of such calculations and certifications.

G. Resubmittals: Subject to same terms and conditions as original submittal.

1. The University will not accept excessive resubmittals.
2. Should excessive resubmittals be required, Contractor may be subject to reimburse the University for Architect's accounts for time spent in processing additional resubmittals at their contractual hourly rate.

1.10 SUBMITTAL REQUIREMENTS

A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment included in the specification section.

1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit complete product information, list as Product Data separate from the Shop Drawings.
2. Mark each submittal to show which products and options are applicable. Clearly indicate all aspects of the proposed items, including material selections and all options specified. Failure to indicate such details could result in the submittal being returned as incomplete.
3. Include the following information, as applicable:

a. Manufacturer's catalog cuts.
b. Manufacturer's product specifications.
c. Standard color charts.
d. Statement of compliance with specified referenced standards.
e. Testing by recognized testing agency, including credentials.
f. Application of testing agency labels and seals.
g. Notation of coordination requirements.
h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:

a. Wiring diagrams that show factory-installed wiring.
b. Printed performance curves.
c. Operational range diagrams.
d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

B. Shop Drawings: Prepare and submit Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data, unless submittal based on Architect's digital data drawing files is otherwise permitted.

1. Preparation: Fully illustrate requirements as shown in the Contract Documents. Include the following information, as applicable:

a. Identification of products.
b. Schedules.
c. Compliance with specified standards.
d. Notation of coordination requirements.
e. Notation of dimensions established by field measurement.
f. Relationship and attachment to adjoining construction clearly indicated.
g. Seal and signature of professional engineer if specified.

2. e-Builder: Submit one PDF copy of each submittal, with any scaled drawings capable of being printed as a full-size drawing.

C. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
2. Sample Identification: Permanently attach label on unexposed side of Samples that includes the following:

    a. Project name and submittal number.
    b. Generic description of Sample.
    c. Product name and name of manufacturer.
    d. Sample source.
    e. Number and title of applicable Specification Section.
    f. Specification paragraph number and generic name of each item.

3. Transmittal: Provide Submittal Identification Form and include complete submittal information indicated. Include photographic image(s) illustrating Sample characteristics, and Sample Identification information for record.
4. e-Builder: Prepare transmittal in PDF form, and upload to website-Builder. Enter required data in site-Builder to fully identify submittal.
5. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

    a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
    b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.

6. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

    a. Number of Samples: Submit two full sets of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return one set with options selected.

7. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for

use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

a. Number of Samples: Submit two sets of Samples. Architect will retain one Sample set; remainder will be returned. Retain one returned Sample set as a project record Sample.

1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

D. Product Schedule (when required or applicable): As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
2. Manufacturer and product name, and model number if applicable.
3. Number and name of room or space.
4. Location within room or space.

E. Qualification Data: Prepare and submit written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.

G. Certificates:

1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.

2. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
4. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
5. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

H. Test and Research Reports:

1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
3. Material Test Reports: Submit reports written by a qualified testing agency, on testing with requirements in the Contract Documents.
4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:

    a. Name of evaluation organization.
    b. Date of evaluation.
    c. Time period when report is in effect.
    d. Product and manufacturers' names.
    e. Description of product.

f. Test procedures and results.
g. Limitations of use.

7. Corrective Action Report: Testing agency shall submit written documentation of any defects found and any corrective action taken, or proposed solutions.

1.11 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 2 – RODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION 013000

SECTION 013110 - 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. Unit-price schedule.
4. Daily construction reports.
5. Material location reports.
6. Field correction reports.
7. Special reports.

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. 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.

C. 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.

D. 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.

E. 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).

F. 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 013240 – ELECTRONIC DATA AVAILABILITY

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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

1.2 DOCUMENT AVAILABILITY

A. Electronic data will be made available at the discretion of the Owner. If approved by the Owner, all of the electronically produced Contract Drawings can be provided as outlined below.

B. Electronic data will be available to the Contractor and its Subcontractors only.

C. Electronic data will be available after the award of the Contract to the Contractor.

D. Documents shall not be used, in whole or in part, for any purpose or project other than the Project that is the subject of the Electronic Data Agreement form (sample attached).

PART 2 - PRODUCTS

2.1 ELECTRONIC DATA FORMAT

A. Electronic data may be only available in certain formats.

PART 3 - EXECUTION

3.1 REQUEST INSTRUCTIONS

A. The procedure to request electronic data shall be for the Contractor to submit to Marshall Craft Associates, Inc. an executed Electronic Data Agreement form. Forms are available upon request. A sample is attached at the end of this Section.

3.2 METHOD OF DELIVERY

A. Electronic data files shall be delivered as follows:

1. Electronic data files will be either transferred electronically (e-mail) or be transferred to CD.
2. Electronic data on CD may be picked-up at Marshall Craft Associates, Inc., or may be shipped via USPS, as requested.

3.3 DELIVERY TIME

A. Electronic data will be available for pick-up or shipped via USPS within 3 working days of receipt of request.

3.4 ATTACHMENTS

A. Sample – Electronic Data Agreement

END OF SECTION 01 32 40

MCA | ARCHITECTURE

Enter today's date

University of Maryland
Bressler Research Building Substations 4-7 Renewal
Project №: 18055.01

ELECTRONIC DATA AGREEMENT

CONTRACTOR AGREEMENT

The undersigned has requested Marshall Craft Associates, Inc. (MCA) provide copies of electronic data to **ENTER COMPANY NAME** , the Recipient, pertaining to **BRESSLER RESEARCH BUILDING SUBSTATIONS 4-7 RENEWAL**, the Project, to assist in the preparation of shop drawings and coordination drawings. In accepting electronic data generated and provided by MCA, the Recipient covenants and agrees that all such data is an instrument of service for MCA, who shall be deemed the author and who shall retain all common law, statutory law and other rights, including copyrights.

The Recipient further agrees not to use this data, in whole or in part, for any purpose or project other than the Project which is the subject of this Agreement. The Recipient agrees to waive all claims against MCA resulting in any way from reuse of the electronic data or any subsequent changes.

Electronic data has been produced to MCA standards and may not conform to recipient standards.

Recipient further understands that many of the final issued documents, which were electronically produced, may contain manually appended information. The electronic data being delivered to you will not contain this manually appended information.

It is also understood by the Recipient that this electronic data is only part of the drawings, specifications and other documents prepared by MCA for the Project; electronic data may not indicate a complete scope of work required for the Project.

The use of this data does not relieve the Recipient, or its subcontractors, of the responsibility for providing complete and coordinated shop drawings as a part of his work on the Project.

In addition, the Recipient agrees, to the fullest extent permitted by law, to indemnify and hold MCA harmless from any damage, liability or cost, including reasonable attorney's fees and costs of defense, arising from any reuse of the electronic data.

Under no circumstances shall this transfer of electronic data or other instruments of service for use by the Recipient be deemed a sale by MCA, and MCA makes no warranties, either express or implied, of merchantability and fitness for any particular purpose.

Accepted for the Contractor:

Name: _____

Title: _____

Company: **ENTER SAME COMPANY NAMES AS ABOVE**

Date: _____

SECTION 013800 - 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 monthly, coinciding with the cutoff date associated with each Application for Payment.

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

SECTION 014000 - 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. The Contractor shall employ and pay a qualified independent testing agency to perform quality-control services for the following list of testing requirements: 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 engage the services of a qualified independent testing agency to perform those services. Payment for these services will be made from the Inspection and Testing Allowance, as authorized by Change Orders.
    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 - PRODUCTS (Not Applicable)

PART 3 - 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 015000 - 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.
B. Temporary utilities include, but are not limited to, the following:

1. Temporary heat.
2. Ventilation.

C. Support facilities include, but are not limited to, the following:
1. Temporary enclosures.
2. Hoists and temporary elevator use.
3. Waste disposal services.
4. Construction aids and miscellaneous services and facilities.

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

1. Temporary fire protection.
2. Barricades, warning signs, and lights.
3. Sidewalk bridge or enclosure fence for the site.
4. 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

A. 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.

B. Lumber and Plywood:

1. For safety barriers, sidewalk bridges, and similar uses, provide minimum 5/8-inch-(16-mm-) thick exterior plywood.

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.

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. 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. 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.

C. 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.

D. 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.

E. 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.

F. Toilets: Use of the University's existing toilet facilities will be permitted, so long as facilities are cleaned and maintained in a condition acceptable to the University. At Substantial Completion, restore these facilities to the condition prevalent at the time of initial use.

G. 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.

H. Wash Facilities: Install wash facilities supplied with potable water at convenient locations for personnel involved in handling materials that require wash-up for a healthy and sanitary condition. Dispose of drainage properly. Supply cleaning compounds appropriate for each condition.

1. Provide safety showers, eyewash fountains, and similar facilities for convenience, safety, and sanitation of personnel.

I. 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.

3.3 SUPPORT FACILITIES INSTALLATION

A. 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.
4. Where temporary wood or plywood enclosure exceeds one hundred (100) sq. ft. (9.2 sq. m) in area, use UL-labeled, fire-retardant-treated material for framing and main sheathing.

B. Temporary Lifts and Hoists: Provide facilities for hoisting materials and employees. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

C. 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.

D. 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^{o}F (27^{o}C). Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material lawfully.

E. 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.

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. Covered Walkway: Erect a structurally adequate, protective covered walkway for passage of persons along the adjacent public street. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction.

1. Construct covered walkways using scaffold or shoring framing. Provide wood plank overhead decking, protective plywood enclosure walls, handrails, barricades,

warning signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage. Extend the back wall beyond the structure to complete the enclosure fence. Paint and maintain in a manner acceptable to the University.

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.

H. Elevator Protection: Provide protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.

1. Do not load elevators beyond their rated weight capacity.
2. Repair damaged components, if any, so no evidence remains of correction.

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 015000

SECTION 016000 - 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.

B. Site plans and floor plans describing delivery routing, necessary street closure, and temporary protection locations.

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, provide 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 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

SECTION 016310 - 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

SECTION 017000 - CONTRACT CLOSEOUT

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) Revisions to routing of piping and conduits.
      4) Revisions to electrical circuitry.
      5) Actual equipment locations.
      6) Duct size and routing.
      7) Locations of concealed internal utilities.
      8) Changes made by change order.
      9) Changes made following the University's written orders.
      10) 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) Testing and qualification of tradesmen.
      2) Documented qualification of installation firms.
      3) Load and performance testing.
      4) Inspections and certifications by governing authorities.
      5) Fire-resistance and flame-spread test results.
      6) Final inspection and correction procedures.

G. Operation and Maintenance Manuals:

1. General Submission Requirements: CM/GC shall use the UMB Master O&M Template pdf file to create the Project O&M Manual. The file can be accessed @ https://www.umaryland.edu/designandconstruction/
   Number 20 in Division 01 General Requirements.

2. UMB O&M Template: CM/GC shall use the UMB Master O&M Template pdf file to create the Project O&M Manual. The file can be accessed @ UMB's Design and Construction Web Site @ https://www.umaryland.edu/designandconstruction/. Under Documents select "See View Current UMB Master O&M Template File

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.

PART 2 - PRODUCTS

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 3 - 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. Identification systems.
7. Control sequences.
8. Hazards.
9. Cleaning.
10. Warranties and bonds.
11. 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. Remove petrochemical spills, stains, and other foreign deposits.
   b. Remove tools, construction equipment, machinery, and surplus material from the site.
   c. 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.
   d. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
   e. Broom clean concrete floors in unoccupied spaces.
   f. Vacuum clean carpet and similar soft surfaces, removing debris and excess nap. Shampoo, if required.
   g. 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.
   h. Remove labels that are not permanent labels.
   i. 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.
   k. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
   l. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
   m. Clean ducts, blowers, and coils if units were operated without filters during construction.
   n. 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.
   o. Leave the Project clean and ready for occupancy.

C. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid the Project of rodents, insects, and other pests.

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

E. 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 017900 – DEMONSTRATION AND TRAINING

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.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:

1. Instruction in operation and maintenance of systems, subsystems, and equipment.

1.3 INFORMATIONAL SUBMITTALS

A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

B. Qualification Data: For instructor.

C. Attendance Record: For each training module, submit list of participants and length of instruction time.

D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.4 QUALITY ASSURANCE

A. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Control," experienced in operation and maintenance procedures and training.

B. Preinstruction Conference: Review methods and procedures related to demonstration and training.

1.5 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Architect.

1.6 INSTRUCTION PROGRAM

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

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

    a. System, subsystem, and equipment descriptions.
    b. Performance and design criteria if Contractor is delegated design responsibility.
    c. Operating standards.
    d. Regulatory requirements.
    e. Equipment function.
    f. Operating characteristics.
    g. Limiting conditions.
    h. Performance curves.

2. Documentation: Review the following items in detail:

    a. Emergency manuals.
    b. Systems and equipment operation manuals.
    c. Systems and equipment maintenance manuals.

d. Product maintenance manuals.
e. Project Record Documents.
f. Identification systems.
g. Warranties and bonds.
h. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

a. Instructions on meaning of warnings, trouble indications, and error messages.
b. Instructions on stopping.
c. Shutdown instructions for each type of emergency.
d. Operating instructions for conditions outside of normal operating limits.
e. Sequences for electric or electronic systems.
f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

a. Startup procedures.
b. Equipment or system break-in procedures.
c. Routine and normal operating instructions.
d. Regulation and control procedures.
e. Control sequences.
f. Safety procedures.
g. Instructions on stopping.
h. Normal shutdown instructions.
i. Operating procedures for emergencies.
j. Operating procedures for system, subsystem, or equipment failure.
k. Seasonal and weekend operating instructions.
l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.

5. Adjustments: Include the following:

a. Alignments.
b. Checking adjustments.
c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

a. Diagnostic instructions.
b. Test and inspection procedures.

7. Maintenance: Include the following:

a. Inspection procedures.
b. Types of cleaning agents to be used and methods of cleaning.
c. List of cleaning agents and methods of cleaning detrimental to product.
d. Procedures for routine cleaning.
e. Procedures for preventive maintenance.
f. Procedures for routine maintenance.
g. Instruction on use of special tools.

8. Repairs: Include the following:

a. Diagnosis instructions.
b. Repair instructions.
c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
d. Instructions for identifying parts and components.
e. Review of spare parts needed for operation and maintenance.

1.7 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 01700 "Contract Closeout."

B. Set up instructional equipment at instruction location.

1.8 INSTRUCTION

A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
1. Owner will furnish Contractor with names and positions of participants.

B. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with Owner with at least seven days' advance notice.

C. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

D. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test.

E. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01 79 00

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. 017900 Demonstration and Training
2. 260000 General Requirements Electrical Systems
3. 260800 Commissioning Electrical Systems

1.2 DEFINITONS

A. 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.

B. 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.

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

D. 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.

E. 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.

F. 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.

G. 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.

H. 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. Perform commissioning services to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures.

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. Construction Manager:

a. Project Manager
b. Test Engineer
c. Subcontractors: As appropriate to product or system being commissioned

1) Specialty Contractor Representatives
2) Controls Representative

2. Commissioning Agent:

a. Project Manager
b. Project Technicians

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 prepare meeting minutes and provide to Owner's PM for distribution.

B. Commissioning Plan:

1. Update as necessary during the work to reflect the progress on the components and systems.

C. Functional Performance Test Forms:

1. Submit no later than thirty (30) calendar days prior to testing, or two (2) weeks after acceptance of ATC submittal.

D. Issues Log: Issue logs document items of non-compliance in materials, installation or operation. Document the results from start-up/pre-functional checklists, functional performance testing, and on-site observations. Include details of the components or systems found to be non-compliant with the drawings, specifications, and approved submittals. Team member responsibilities related to issues identified during commissioning are covered in Part 3 of this specification.

1. Update as necessary during the work to reflect the progress on the components and systems.

E. Final Commissioning Report: Compile a final commissioning report summarizing all the tasks, findings, conclusions, and recommendations of the commissioning process. Indicate the actual performance of the building systems in reference to the Owner's Requirements and contract documents. Include completed pre-functional inspection checklists, functional performance testing records, Issues Log, and a summary of commissioning activities.

1.6 DESIGN REVIEW AND DOCUMENTATION

A. Document Basis of Design and Project Requirements as they relate to project functional performance and environmentally responsive characteristics, including:

1. Functionality
2. Energy Performance
3. Maintainability
4. System Cost

B. Review design documents to verify that each commissioned system meets the Project Requirements.

C. Review construction documents to verify that commissioning is adequately specified, that each commissioned system can be commissioned and is likely to meet the Project Requirements.

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 CxA, 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. Design Document Review
    b. 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 DESIGN REVIEW AND DOCUMENTATION

A. Design Document Review: Review design documents at two phases of design to verify that each commissioned system meets the Owner's requirements with special attention on integrated systems, building automation controls, and functional performance. Design review comments shall be submitted in writing to A/E and Owner. A/E will respond in writing to all comments prior to next document submission.

B. Controls Coordination Review Meeting: Comply with the following:

1. Schedule, coordinate, and facilitate a two hour meeting during design phase between 50% CD and 95% CD submissions, or at a point in design where the building automation control design is at least 50% complete and includes system diagrams and sequences of operation.
2. Attendees shall include the design engineer, University O&M representative, controls contractor, and CxA.
3. The team shall review all sequences of operation to determine whether they are complete, accurate, and meet with university standards and operating practices. Special attention shall be paid to interactions between new systems and equipment and existing building and campus controls systems.

C. Construction Document Review: Review final construction documents to confirm that all design review comments have been resolved.

3.3 COMMISSIONING SCOPE MEETINGS

A. Commissioning Scope Meeting – Construction Phase:

1. Schedule, coordinate, and facilitate a scoping meeting at the start of construction after the subcontractors have been selected. This will be part of a regular subcontractor meeting.
2. All Cx Team members shall be in attendance.
3. Review the Cx process with special attention on the construction phase requirements.

3.4 COMMISSIONING PLAN

A. Develop a Commissioning (Cx) Plan to identify how commissioning activities will be integrated into general construction and trade activities. The Cx Plan shall identify how commissioning responsibilities are distributed. The intent of this plan is to raise questions and issues and resolve them with input from the entire Cx Team early in construction.

1. Identify who will be responsible for producing the various procedures, reports, and forms.
2. Determine what Cx activities will be scheduled and how they are incorporated into the project schedule.
3. Describe the testing and acceptance procedures.

3.5 SUBMITTAL REVIEW

A. Identify Submittals for Commissioning Review:

1. At start of Construction Phase, GC shall provide a complete submittal register to the CxA. The CxA shall identify which submittal packages should be reviewed for coordination with the commissioning scope. The University shall confirm and/or amend the list and return it to the GC. During submittal phase, submittals identified as Cx submittals shall be sent to the CxA and the Engineer of Record concurrently for review.

B. General Systems to be Commissioned:

1. Concurrently with the Engineer of Record, review the equipment and system submittals for the equipment to be commissioned to verify that the submitted equipment meets the requirements of the contract documents and the OPR. Focus on integration of equipment within the building systems.

C. Controls Submittal Review

1. Concurrently with the Engineer of Record, review the Automatic Temperature Control submittal to verify that the submitted design meets the requirements of the contract documents, the OPR, and the design intent for the operation of the building systems. After submittal review is complete, schedule the Commissioning Controls Coordination Meeting prior to manufacturer's resubmittal of ATC package. Only if the submittal is accepted with no comments noted by the A/E team, the Commissioning Controls Coordination Meeting may be skipped.

3.6 COMMISSIONING CONTROLS COORDINATION MEETING

A. Meeting Attendees:

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

B. After the first controls submittal review is complete, schedule, coordinate and facilitate the Commissioning Controls Coordination Meeting, if necessary. Project scope may not require this meeting. Meeting will be held at the discretion of the owner."

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.

3.7 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.

3.8 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. Develop FPT procedures for equipment and systems identify specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Coordinate test procedures with the contractor for feasibility, safety, equipment, and warranty protection. Functional performance test forms shall include the following information at a minimum:

1. System and equipment or component name(s)
2. Equipment location and ID number
3. Date
4. Project name
5. Participants
6. Test Set-up instructions including special requirements and alarm limits.

7. Step-by-step test procedure
8. Acceptance criteria
9. Comments

C. Coordinate, observe, and record the results of the FPT's:

1. Coordinate retesting as necessary until correct performance is verified.
2. Verify the intended operation of individual components and system interactions under all design conditions and modes of operation.
3. Identify deficiencies during testing and include on FPT forms and the Issues Log
4. Confirm set-up of trend logs and collect data after the sample time period.

3.9 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.

3.10 OPERATIONS AND MAINTENANCE TRAINING

A. Reference 017900 "DEMONSTRATION AND TRAINING"

B. Verify and document training:

1. Training Verification:

a. Dates, Start and Finish Times, and Locations

b. Outline of the Training Agenda
c. Names and qualifications of presenters
d. Completed sign-in sheet from training sessions

C. Review O&M materials.

3.11 FINAL COMMISSIONING REPORT

A. Final Commissioning Report: Compile final commissioning report. Summarize all the tasks, findings, conclusions and recommendations from the Commissioning process. Include a "Lessons Learned" section.

3.12 DEFERRED AND SEASONAL TESTING

A. If a test cannot be completed due to building conditions, occupancy, weather, or seasonal conditions, the functional testing may be delayed upon the recommendation of the CxA and the approval of the Owner.

3.13 TEAM RESPONSIBILITIES

A. Owner's Responsibilities:

1. 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. Testing and demonstration of systems, subsystems and equipment.
d. Training in operation and maintenance of systems, subsystems and equipment.
e. Final review and acceptance meetings.
f. Provide utility services required for the commissioning process.
g. Coordinate any seasonal or deferred testing.

B. Architect / Engineer's Responsibilities:

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

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

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

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

5. 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.

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) Perform two (2) focused reviews of the drawings and specification during design phase.
2) 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.

3) 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 GC 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, 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, 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 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 DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

B. Related Requirements:

1. Section 01010 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
2. Section 01045 "Cutting and Patching" for cutting and patching procedures.
3. Section 01500 "Construction Facilities and Temporary Controls" for general protection and work procedures.

1.3 DEFINITIONS

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

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.4 MATERIALS OWNERSHIP

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

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For refrigerant recovery technician.

B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and , for noise control. Indicate proposed locations and construction of barriers.

C. 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 on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

D. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 01 380 "Construction Photographs." Submit before Work begins.

E. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.6 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

1.7 QUALITY ASSURANCE

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

1.8 FIELD CONDITIONS

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

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

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 suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Hazardous Materials: Present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.

1. Hazardous material remediation is specified elsewhere in the Contract Documents.
2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.

3. Owner will provide material safety data sheets for suspected hazardous materials that are known to be present in buildings and structures to be selectively demolished because of building operations or processes performed there.

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

G. 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.

1.9 COORDINATION

A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

D. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs.

1. Comply with requirements specified in Section 01380 "Construction Photographs"
2. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.

3.2 PREPARATION

A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. Arrange to shut off utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
    a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
    c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.

e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.4 PROTECTION

A. Temporary Protection: 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 01500 "Construction Facilities and Temporary Controls."

B. Temporary Shoring: Design, 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.

C. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION, GENERAL

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

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. 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 portable fire-suppression devices during flame-cutting operations.
5. Maintain fire watch during and for at least twelve hours after flame-cutting operations.
6. Maintain adequate ventilation when using cutting torches.
7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
10. Dispose of demolished items and materials promptly. Comply with requirements in Section 01 74 19 "Construction Waste Management and Disposal."

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

C. Removed and Salvaged Items:
1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area designated by Owner.
5. Protect items from damage during transport and storage.

D. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

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

3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

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

B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and 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. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings."

3.7 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.

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

3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

B. Burning: Do not burn demolished materials.

3.8 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

SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

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. Wood blocking and nailers.
2. Wood furring.
3. Plywood panel.

1.3 DEFINITIONS

A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.

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

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with

requirements. Indicate type of preservative used and net amount of preservative retained.

2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.5 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, .
3. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 15 percent unless otherwise indicated.

2.2 FIRE-RETARDANT-TREATED MATERIALS

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

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Treatment shall not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated.
4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D5664, and design value adjustment factors shall be calculated according to ASTM D6841.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

E. Application: Treat all miscellaneous carpentry unless otherwise indicated.

2.3 Wood-preservative

2.4 PLYWOOD BACKING PANELS

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

2.5 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, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M of Type 304 stainless steel.

B. Screws for Fastening to Metal Framing: ASTM C1002, length as recommended by screw manufacturer for material being fastened.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels.

D. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

E. Do not splice structural members between supports unless otherwise indicated.

F. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.

G. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:

1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal thickness.
3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. and to solidly fill space below partitions.
4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet o.c.

H. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

I. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

J. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

K. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
3. ICC-ES evaluation report for fastener.

L. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 INSTALLATION OF WOOD BLOCKING AND NAILER

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 PROTECTION

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

B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061053

SECTION 072100 – THERMAL INSULATION

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. Extruded polystyrene foam-plastic board insulation.

B. Related Requirements:

1. Section 092900 "Gypsum Board" for Glass-fiber blanket insulation.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Extruded polystyrene foam-plastic board insulation.

1.4 DELIVERY, STORAGE AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION

A. Extruded Polystyrene Board Insulation, Type X: ASTM C578, Type X, 15-psi minimum compressive strength; unfaced.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. DiversiFoam Products.
   b. Dow Chemical Company (The).
   c. Owens Corning.
2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
3. Smoke-Developed Index: Not more than 450 when tested in accordance with ASTM E84.
4. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
5. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

2.2 ACCESSORIES

A. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Install insulation with manufacturer's R-value label exposed after insulation is installed.

D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

E. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF CAVITY-WALL INSULATION

A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face and as recommended by manufacturer.

1. Fit courses of insulation, with edges butted tightly in both directions, and with faces flush.
2. Press units firmly against inside substrates.

3.4 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

SECTION 077200 - ROOF ACCESSORIES

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. Roof hatches.

1.3 COORDINATION

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of roof accessory.

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

B. Shop Drawings: For roof accessories.

1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

2.2 ROOF HATCHES

A. Roof Hatches: Metal roof-hatch units with lids and insulated double-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, and integrally formed deck-mounting flange at perimeter bottom.

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. Babcock-Davis.
   b. BILCO Company (The).
   c. Custom Solution Roof and Metal Products.
   d. Milcor; a division of Hart & Cooley, Inc.

B. Type and Size: Double-leaf lid, 96-inch by 108-inch.

C. Loads: Minimum 40-lbf/sq. ft. external live load and 20-lbf/sq. ft. internal uplift load.

D. Hatch Material: Aluminum sheet.

1. Thickness: 0.090 inch minimum.
2. Finish: Mill.

E. Construction:

1. Insulation: 2-inch- thick, polyisocyanurate board.
   a. R-Value: 12.0 according to ASTM C1363.
2. Nailer: Factory-installed wood nailer continuous around hatch perimeter.
3. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
4. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
5. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
6. Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is tapered to accommodate roof slope so that top surfaces of perimeter curb are level. Equip hatch with water diverter or cricket on side that obstructs water flow.

F. Hardware: Spring operators, hold-open arm, stainless steel spring latch with turn handles, stainless steel butt- or pintle-type hinge system, and padlock hasps inside.

1. Provide two-point latch on lids larger than 84 inches.

2.3 METAL MATERIALS

A. Aluminum Sheet: ASTM B209, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.

1. Mill Finish: As manufactured.

B. Aluminum Extrusions and Tubes: ASTM B221, manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.

C. Steel Shapes: ASTM A36/A36M, hot-dip galvanized according to ASTM A123/A123M unless otherwise indicated.

D. Steel Tube: ASTM A500/A500M, round tube.

E. Galvanized-Steel Tube: ASTM A500/A500M, round tube, hot-dip galvanized according to ASTM A123/A123M.

F. Steel Pipe: ASTM A53/A53M, galvanized.

2.4 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.

C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick.

D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

E. Underlayment:

1. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
2. Polyethylene Sheet: 6-mil- thick polyethylene sheet complying with ASTM D4397.
3. Slip Sheet: Building paper, 3 lb/100 sq. ft. minimum, rosin sized.
4. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

F. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:

1. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A153/A153M or ASTM F2329.
2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
3. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.

G. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

H. Elastomeric Sealant: ASTM C920, elastomeric polyurethane polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

I. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

J. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

2.5 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Verify dimensions of roof openings for roof accessories.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install roof accessories according to manufacturer's written instructions.

1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.

2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.

C. Roof Curb Installation: Install each roof curb so top surface is level.

D. Equipment Support Installation: Install equipment supports so top surfaces are level with each other.

E. Roof-Hatch Installation:

1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
2. Attach safety railing system to roof-hatch curb.
3. Attach ladder-assist post according to manufacturer's written instructions.

F. Seal joints with elastomeric sealant as required by roof accessory manufacturer.

3.3 REPAIR AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A780/A780M.

B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 099113 "Exterior Painting."

C. Clean exposed surfaces according to manufacturer's written instructions.

D. Clean off excess sealants.

E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200

SECTION 024119 – SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sprayed fire-resistive materials.

1.3 DEFINITIONS

A. SFRM: Sprayed fire-resistive materials.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Sprayed fire-resistive material.
2. Substrate primers

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For installer.

B. Product Certificates: For each type of sprayed fire-resistive material.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by sprayed fire-resistive material manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not apply fire protection when ambient or substrate temperature is 40 deg F or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.

B. Ventilation: Ventilate building spaces during and after application of fire protection, providing complete air exchanges according to manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fire protection dries thoroughly.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Assemblies: Provide fire protection, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.

B. Source Limitations: Obtain fire protection from single source.

C. Asbestos: Provide products containing no detectable asbestos.

2.2 SPRAYED FIRE-RESISTIVE MATERIALS

A. Sprayed Fire-Resistive Material : Manufacturer's standard, factory-mixed, lightweight, dry formulation, complying with indicated fire-resistance design, and mixed with water at Project site to form a slurry or mortar before conveyance and application.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Isolatek International; Cafco 400 or comparable product by one of the following:

   a. Carboline Company; a subsidiary of RPM International.
   b. GCP Applied Technologies Inc.
   c. Pyrok, Inc.

2. Bond Strength: Minimum 8.556-lbf/sq. ft. cohesive and adhesive strength based on field testing according to ASTM E736.

3. Density: Not less than density specified in the approved fire-resistance design, according to ASTM E605.

4. Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design or ASTM E605, whichever is thicker, but not less than 0.375 inch.

5. Combustion Characteristics: ASTM E136.
6. Compressive Strength: Minimum 22,112 psf according to ASTM E761.
7. Corrosion Resistance: No evidence of corrosion according to ASTM E937.
8. Deflection: No cracking, spalling, or delamination according to ASTM E759.
9. Effect of Impact on Bonding: No cracking, spalling, or delamination according to ASTM E760.
10. Air Erosion: Maximum weight loss of 0.000 g/sq. ft. in 24 hours according to ASTM E859.
11. Fungal Resistance: Treat products with manufacturer's standard antimicrobial formulation to result in no growth on specimens per ASTM G21.

2.3 AUXILIARY MATERIALS

A. Provide auxiliary materials that are compatible with sprayed fire-resistive material and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

B. Substrate Primers: Primers approved by sprayed fire-resistive material manufacturer and complying with one or both of the following requirements:

1. Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
2. Primer's bond strength in required fire-resistance design complies with specified bond strength for sprayed fire-resistive material and with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests according to ASTM E736.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and according to each fire-resistance design.

1. Verify that substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and

encapsulants, or other foreign substances capable of impairing bond of fire protection with substrates under conditions of normal use or fire exposure.

2. Verify that objects penetrating fire protection, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.

3. Verify that substrates receiving fire protection are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fire protection application.

B. Verify that roof construction, installation of rooftop HVAC equipment, and other related work are complete before beginning Work.

C. Conduct tests according to sprayed fire-resistive material manufacturer's written instructions to verify that substrates are free of substances capable of interfering with bond.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Cover other work subject to damage from fallout or overspray of fire protection materials during application.

B. Clean substrates of substances that could impair bond of fire protection.

C. Prime substrates where included in fire-resistance design and where recommended in writing by sprayed fire-resistive material manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fire protection.

D. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fire protection. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

3.3 APPLICATION

A. Construct fire protection assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting fire protection Work.

B. Comply with sprayed fire-resistive material manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fire protection; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

C. Coordinate application of fire protection with other construction to minimize need to cut or remove fire protection.

1. Do not begin applying fire protection until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
2. Defer installing ducts, piping, and other items that would interfere with applying fire protection until application of fire protection is completed.

D. Where new materials join existing materials, ensure compatibility of materials with each other.

E. Install auxiliary materials as required, as detailed, and according to fire-resistance design and sprayed fire-resistive material manufacturer's written instructions for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by sprayed fire-resistive material manufacturer.

F. Spray apply fire protection to maximum extent possible. After the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by sprayed fire-resistive material manufacturer.

G. Extend fire protection in full thickness over entire area of each substrate to be protected.

H. Install body of fire protection in a single course unless otherwise recommended in writing by sprayed fire-resistive material manufacturer.

I. Provide a uniform finish complying with description indicated for each type of fire protection material and matching finish approved for required mockups.

J. Cure fire protection according to sprayed fire-resistive material manufacturer's written instructions.

K. Do not install enclosing or concealing construction until after fire protection has been applied, inspected, and tested and corrections have been made to deficient applications.

3.4 FIELD QUALITY CONTROL

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

1. Test and inspect as required by the IBC Subsection 1705.14, "Sprayed Fire-Resistant Materials."

B. Fire protection will be considered defective if it does not pass tests and inspections.

1. Remove and replace fire protection that does not pass tests and inspections, and retest.
2. Apply additional fire protection, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.

3.5 CLEANING

A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

3.6 PROTECTION

A. Protect fire protection, according to advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fire protection is without damage or deterioration at time of Substantial Completion.

3.7 REPAIRS

A. As installation of other construction proceeds, inspect fire protection and repair damaged areas and fire protection removed due to work of other trades.

B. Repair fire protection damaged by other work before concealing it with other construction.

C. Repair fire protection by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

END OF SECTION 078100

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. Interior standard steel doors and frames.

B. Related Requirements:

1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.
2. Section 099123 "Interior Painting" for prime finish.

1.3 DEFINITIONS

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

1.4 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.

1.6 INFORMATIONAL SUBMITTALS

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

1.7 CLOSEOUT SUBMITTALS

1.8 QUALITY ASSURANCE

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch- high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ceco Door; ASSA ABLOY.
2. Curries Company; ASSA ABLOY.
3. Steelcraft; an Allegion brand.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.
2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
3. Temperature-Rise Limit: , provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.

2.3 INTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B. unless otherwise indicaed on drawings .

1. Doors:
   a. Type: As indicated in the Door and Frame Schedule.
   b. Thickness: 1-3/4 inches.
   c. Face: Uncoated steel sheet, minimum thickness of 0.042 inch.
   d. Edge Construction: Model 1, Full Flush Model 2, Seamless.
   e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
   f. Fire-Rated Core: Manufacturer's standard vertical steel stiffener core for fire-rated doors.
2. Frames:
   a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch.
   b. Frames: Fabricated from same thickness material as adjacent door frame.
   c. Construction: Full profile welded.
3. Exposed Finish: Factory primed.

2.4 FRAME ANCHORS

A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
3. Postinstalled Expansion Anchor: Minimum 3/8-inch- diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

2.5 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.

E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

2.6 FABRICATION

A. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
    a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
    b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

B. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to ANSI/SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

2.7 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

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

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.

B. Hollow-Metal Frames: Comply with ANSI/SDI A250.11 NAAMM-HMMA 840.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
   a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
   b. Install frames with removable stops located on secure side of opening.
2. Fire-Rated Openings: Install frames according to NFPA 80.
3. Floor Anchors: Secure with postinstalled expansion anchors.
   a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
4. Solidly pack mineral-fiber insulation inside frames.
5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors.
7. Installation Tolerances: Adjust hollow-metal frames 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 and adjust hollow-metal doors accurately in frames, within clearances specified below.

1. Non-Fire-Rated Steel Doors: Comply with .
2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
3. Smoke-Control Doors: Install doors according to NFPA 105.

3.3 REPAIR

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

B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

C. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.

D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081113

SECTION 087100 - DOOR HARDWARE

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. Mechanical door hardware for the following:
   a. Swinging doors.

B. Related Requirements:

1. Section 081113 "Hollow Metal Doors and Frames".

1.3 COORDINATION

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

B. Security: Coordinate installation of door hardware, keying, and access control with Owner.

1.4 PREINSTALLATION MEETINGS

A. Keying Conference: Conduct conference at location to be determined by Owner.

1. Conference participants shall include Installer's Architectural Hardware Consultant and Owner.
2. Incorporate conference decisions into keying schedule after reviewing door hardware keying system including, but not limited to, the following:
   a. Flow of traffic and degree of security required.
   b. Preliminary key system schematic diagram.
   c. Requirements for key control system.
   d. Requirements for access control.
   e. Address for delivery of keys.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

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

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

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For compliance with accessibility requirements, for tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.

C. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of door hardware to include in maintenance manuals.

B. Schedules: Final door hardware and keying schedule.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

D. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures including excessive deflection, cracking, or breakage.
   b. Faulty operation of doors and door hardware.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
2. Warranty Period: Three years from date of Substantial Completion unless otherwise indicated below:
   a. Locks: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of door hardware from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Where fire-rated doors are indicated, provide door hardware complying with NFPA 80 that is 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. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

2.3 FABRICATION

A. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.

B. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where

through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

2. Fire-Rated Applications:
   a. Wood or Machine Screws: For the following:
      1) Hinges mortised to doors or frames.
      2) Strike plates to frames.
      3) Closers to doors and frames.
   b. Steel Through Bolts: For the following unless door blocking is provided:
      1) Surface hinges to doors.
      2) Closers to doors and frames.
      3) Surface-mounted exit devices.
3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
4. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.4 FINISHES

A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
2. Custom Steel Doors and Frames: HMMA 831.

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."

D. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

E. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
2. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 70 degrees and so that closing time complies with accessibility requirements of authorities having jurisdiction.
3. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.

B. Occupancy Adjustment: Approximately three months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.5 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.6 DOOR HARDWARE SCHEDULE

A. Hardware Set 1: Each opening to have the following:

Qty		Description	Catalog Number	Finish	B.O.D Mfr	Acceptable Mfrs
6	EA	HW HINGE	5BB1HW 4.5 X 4.5	630	IVE	MCK, STA
1	EA	FIRE EXIT HARDWARE	9847-L-F-LBR-ER12-996-06	626	VON	COR, STA
1	EA	FIRE EXIT HARDWARE	9847-L-F-LBR-EO	626	VON	COR, STA
1	EA	RIM CYLINDER	1193-6	630	YAL	SAR, STA
1	EA	PERMANENT CORE	PER FACILITY KEY SYSTEM	626	YAL	SAR, STA
2	EA	SURFACE CLOSER	4111 CUSH	689	LCN	COR, STA
2	EA	KICK PLATE	8400 10" X 1 1/2" LDW B4E	630	IVE	ROC, STA
1	SET	SEALS	2525B	BRN	NGP	ZI, PEM
1	SET	MEETING STILE SEALS	5060B	BRN	NGP	ZI, PEM
1	EA	DOOR SWEEP	100VA	CL	NGP	ZI, PEM
1	EA	THRESHOLD	513	AL	NGP	ZI, PEM

Manufacturers Legend:

COR Corbin Ruswin
IVE Ives
LCN LCN
MCK McKinney
NGP National Guard Products
PEM Pemko
ROC Rockwood

SAR Sargent
STA Stanley
VON VonDuprin
YAL Yale
ZI Zero International

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 partitions.

B. Related Requirements:

1. Section 092900 "Gypsum Board".

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.

B. Horizontal Deflection: For composite wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 10 lbf/sq. ft.

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 steel unless otherwise indicated.
2. Protective Coating: ASTM A 653/A 653M, G40, hot-dip galvanized unless otherwise indicated.

B. Studs and Tracks: ASTM C 645.

1. Steel Studs and Tracks:
   a. Manufacturers: Subject to compliance with requirements, provide products by the following:
      1) MarinoWARE.
      2) SCAFCO Steel Stud Company.
      3) Steel Construction Systems.
   b. Minimum Base-Steel Thickness: As indicated on Drawings .
   c. Depth: As indicated on Drawings .

C. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width 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. MarinoWARE.
   b. SCAFCO Steel Stud Company.
   c. Steel Construction Systems.
2. Minimum Base-Steel Thickness: 0.0329 inch .

D. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-steel thickness, with minimum 1/2-inch- wide flanges.

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. MarinoWARE.
   b. SCAFCO Steel Stud Company.

c. Steel Construction Systems.
2. Depth: 1-1/2 inches .
3. Clip Angle: Not less than 1-1/2 by 1-1/2 inches , 0.068-inch- thick, galvanized steel.

2.3 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

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 Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

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

3.4 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Single-Layer Application: 16 inches o.c. unless otherwise indicated.

B. Install studs so flanges within framing system point in same direction.

C. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
   a. Install two studs at each jamb unless otherwise indicated.

D. 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.

END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

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.

B. Related Requirements:

1. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Abuse-resistant gypsum board.
2. Joint treatment materials.

1.4 QUALITY ASSURANCE

1.5 DELIVERY, STORAGE AND HANDLING

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

1.6 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, moisture damaged, and mold damaged.

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

2.2 GYPSUM BOARD, GENERAL

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

2.3 INTERIOR GYPSUM BOARD

A. Abuse-Resistant Gypsum Board: ASTM C1396/C1396M gypsum board, tested according to ASTM C1629/C1629M.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. American Gypsum.
   b. CertainTeed Gypsum.
   c. National Gypsum Company.
   d. USG Corporation.
2. Core: 5/8 inch , Type X.
3. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds Level 2 requirements.
4. Indentation: ASTM C1629/C1629M, meets or exceeds Level 1 requirements.
5. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds Level 2 requirements.
6. Long Edges: Tapered.
7. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.4 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints 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.
5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound .

2.5 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Steel Drill Screws: ASTM C1002 unless otherwise indicated.

1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

C. Glass-Fiber Blanket Insulation, Unfaced: ASTM C665, Type I; passing ASTM E136 for combustion.

1. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
2. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION AND FINISHING OF PANELS, GENERAL

A. Comply with ASTM C840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.

3.3 INSTALLATION OF INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:

1. Abuse-Resistant Type: Unless otherwise noted. .

B. Single-Layer Application:

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

3.4 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 and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:

1. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
   a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

3.5 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

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

END OF SECTION 092900

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

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. Vinyl base.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Initial Selection: For each type of product indicated.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.6 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F , in spaces to receive resilient products during the following periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F .

C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 VINYL BASE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Armstrong World Industries, Inc.

2. Johnsonite; a Tarkett company.
3. Roppe Corporation, USA.

B. Product Standard: ASTM F 1861, Type TV (vinyl, thermoplastic).

1. Group: I (solid, homogeneous) .
2. Style and Location:
   a. Style B, Cove: .

C. Minimum Thickness: 0.125 inch .

D. Height: 4 inches .

E. Lengths: Coils in manufacturer's standard length .

F. Outside Corners: Preformed .

G. Inside Corners: Job formed or preformed.

H. Colors: To be selected by Architect from manufacturer's full range.

2.3 INSTALLATION MATERIALS

A. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

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

1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Do not install resilient products until materials are the same temperature as space where they are to be installed.

1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.

C. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. Preformed Corners: Install preformed corners before installing straight pieces.

G. Job-Formed Corners:

1. Outside Corners: Not permitted.
2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 6 inches in length.
   a. Miter corners to minimize open joints.

3.4 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Stair Accessories:

1. Tightly adhere to substrates throughout length of each piece.
2. For treads installed as separate, equal-length units, install to produce a flush joint between units.

C. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Perform the following operations immediately after completing resilient-product installation:

1. Remove adhesive and other blemishes from surfaces.
2. Sweep and vacuum horizontal surfaces thoroughly.
3. Damp-mop horizontal surfaces to remove marks and soil.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513

SECTION 099113 - EXTERIOR PAINTING

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. Primers.
2. Finish coatings.

B. Related Requirements:

1. Section 051200 "Structural Steel Framing" for shop priming of metal substrates.
2. Section 055000 "Metal Fabrications" for shop priming metal fabrications.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include preparation requirements and application instructions.
2. Indicate VOC content.

B. Samples for Verification: For each type of paint system and each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint Products: 5 percent, but not less than 1 gal. of each material and color applied.

1.5 QUALITY ASSURANCE

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 in snow, rain, fog, or mist; 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Benjamin Moore & Co.

2. PPG Paints.
3. Sherwin-Williams Company (The).

B. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to products listed in the Interior Painting Schedule for the paint category indicated.

C. Source Limitations: Obtain each paint product from single source from single manufacturer.

2.2 PAINT PRODUCTS, 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 topcoat manufacturer for use in paint system and on substrate indicated.

B. Colors: Match Architect's samples.

2.3 PRIMERS

A. Water-Based, Rust-Inhibitive Primer: Corrosion-resistant, water-based-emulsion primer formulated for resistance to flash rusting when applied to cleaned, exterior ferrous metals subject to mildly corrosive environments.

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. S-W Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series.

2.4 FINISH COATINGS

A. Exterior, Water-Based, Light Industrial Coating, Gloss: Corrosion-resistant, water-based, pigmented, emulsion coating formulated for resistance to blocking (sticking of

two painted surfaces), water, alkalis, moderate abrasion, and mild chemical exposure and for use on exterior, primed, wood and metal surfaces.

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. S-W Pro Industrial Acrylic Gloss, B66-600 Series.
2. Gloss Level: Manufacturer's standard gloss finish.

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. Verify suitability of substrates, including surface conditions and compatibility, with finishes and primers.

C. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

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 specified in this Section.

D. 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.

E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

3.3 INSTALLATION

A. Apply paints in accordance with manufacturer's written instructions.

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
3. Primers specified in the Exterior Painting Schedule may be omitted on items that are factory primed or factory finished if compatible with intermediate and topcoat coatings and acceptable to intermediate and topcoat paint manufacturers.

B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. 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.

3.4 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
3. Allow empty paint cans to dry before disposal.
4. Collect waste paint by type and deliver to recycling or collection facility.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 EXTERIOR PAINTING SCHEDULE

A. Steel and Iron Substrates:

1. Water-Based, Light Industrial Coating System:
   a. Prime Coat: Exterior, water-based, rust inhibitive primer (DFT 1.9-3.8 mils, per coat).
   b. Intermediate Coat: Matching topcoat.
   c. Topcoat: Exterior, water-based, light industrial coating, gloss (DFT 2.1-4.2 mils, per coat).

END OF SECTION 099113

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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes surface preparation and the application of paint systems on the following interior substrates:

1. Concrete.
2. Steel and iron.
3. Wood.
4. Gypsum board.

B. Related Requirements:

1. Section 081113 "Hollow Metal Doors and Frames" for shop priming doors and frames.

1.3 DEFINITIONS

A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

G. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
2. Indicate VOC content.

B. 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. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.6 QUALITY ASSURANCE

1.7 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.

1.8 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Benjamin Moore & Co.
2. PPG Paints.
3. Sherwin-Williams Company (The).

B. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to products listed in the Interior Painting Schedule for the paint category indicated.

2.2 PAINT, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

C. Colors: Match Architect’s samples.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Wood: 15 percent.
3. Gypsum Board: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

F. Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."

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.

3.4 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.

3.5 INTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Nontraffic Surfaces (Pedestrian and Cart):

1. Latex System :
   a. Semi-Gloss Finish (MPI Gloss Level 5):
      1) 1st Coat: S-W Tread-Plex Acrylic Floor Coating, B90 Series. (DFT 1.5-2.0 mils, per coat).
      2) 2nd Coat: S-W Tread-Plex Acrylic Floor Coating, B90 Series. (DFT 1.5-2.0 mils, per coat).

B. CMU and Cast In-Place Concrete (Wall Surfaces):

1. Latex system:
   a. Semi-Gloss Finish (MPI Gloss Level 5):
      1) 1st Coat: S-W Loxon Block Surfacer LX01W0200. Coverage sq.ft. per gallon 50-100. (DFT 8-9 mils, per coat).
      2) 2nd Coat: S-W Pro Industrial Acrylic Semi-Gloss, B66-650 Series (DFT 2.1 – 4.2 mils, per coat).
      3) 2nd Coat: S-W Pro Industrial Acrylic Semi-Gloss, B66-650 Series (DFT 2.1 – 4.2 mils, per coat).

C. Hollow Metal Doors and Frames:

1. Latex over Shop-Applied Quick-Drying Shop Primer System:
   a. Semi-Gloss Finish (MPI Gloss Level 5):
      1) 1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series (DFT 1.9-3.8 mils, per coat).
      2) 2nd Coat: S-W Pro Industrial Acrylic Semi-Gloss, B66-650 Series (DFT 2.1 – 4.2 mils, per coat).
      3) 3rd Coat: S-W Pro Industrial Acrylic Semi-Gloss, B66-650 Series (DFT 2.1 – 4.2 mils, per coat).

D. Wood and Gypsum Board Substrates:

1. Latex over Latex Primer System:
   a. Egg shell Finish (MPI Gloss Level 3):
      1) 1st Coat: S-W Pro Pro Block Primer/Sealer, B51-600 Series (DFT 1.4 mils, per coat).
      2) 2nd Coat: S-W ProMar 200 HP Zero VOC Interior Latex, Eg-Shel B20-1900 Series (DFT 1.7 mils, per coat).
      3) 3rd Coat: S-W ProMar 200 HP Zero VOC Interior Latex, Eg-Shel B20-1900 Series (DFT 1.7 mils, per coat).

E. Repaint over glossy surfaces:

1. Acrylic over a Bonding Primer:
   a. Semi-Gloss Finish (MPI Gloss Level 5):
      1) 1st Coat: S-W Extreme Bond Primer B51-1150 Series (DFT 1.0 mils, per coat).
      2) 2nd Coat: S-W Pro Industrial Acrylic Semi-Gloss, B66-650 Series (DFT 2.1 – 4.2 mils, per coat).
      3) 3rd Coat: S-W Pro Industrial Acrylic Semi-Gloss, B66-650 Series (DFT 2.1 – 4.2 mils, per coat).

END OF SECTION 099123

DIVISION 210000 – FIRE PROTECTION

PART 1 - GENERAL:

1.1 RELATED DOCUMENTS

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

1.2 SCOPE:

A. The fire protection contractor shall furnish all labor, material, tools, equipment and services necessary and incidental for installing all fire protection systems shown on the drawings, indicated in the specification, or necessary to provide a finished installation. The finished installation shall be in perfect working condition and be ready for continuous and satisfactory operation. The project area is located in the BRB building on the 14th Floor and Penthouse. 11th floor. Construction will be done in phases to support limited shutdown events in the building. See architect's supplemental materials for more detail.

1.3 CODES AND REGULATIONS

A. All materials furnished and all work installed shall comply with the codes and regulations adapted by the State of Maryland and recommendations of the following bodies:

1. International Building Code (IBC)
2. National Fire Protection Association (NFPA)
3. Maryland State Fire Prevention Code

1.4 RESPONSIBILITY

A. The Construction Manager/General Contractor (GC/CM) shall be responsible for all work included in Division 21. The delegation of work to other contractors shall not relieve him of this responsibility. Contractors who perform work under these sections shall be responsible to the CM/GC.

1.5 SITE VISIT

A. Prior to preparing the bid, the fire protection contractor shall visit the site and become familiar with all existing conditions. Make all necessary investigations as to locations of utilities and existing field conditions that could 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 contractor shall submit an outage request to the University of Maryland, Baltimore (UMB) Project Manager, using the UMB Standard Request for Outage Form which is available through the UMB Web Site at http://www.umaryland.edu/designandconstruction/, under the "Documents" link. The existing mechanical/electrical/fire protection systems 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 business days (10) days in advance with the UMB Design and Construction Department. Outages shall be performed during normal duty hours. If necessary, some outage work may be performed outside normal hours if approved by UMB.

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 and the UMB Design and Construction Department.

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 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 operated by University personnel only. Unauthorized operation of fire protection valves or other control devices by contractors and their personnel will result in extremely serious consequences for which the contractor will be held accountable.

1.7 DESIGNER/INSTALLER QUALIFICATIONS

A. Designer: Field survey, design, and preparation of the submittals required by the specifications shall be performed and certified by an individual who is a registered professional engineer or who is certified as a Level III or IV Technician by NICET in Water-Based Systems Layout. The designer shall have a minimum of five (5) years' experience in the preparation of sprinkler shop drawings, hydraulic calculations, and field surveying. The system designer shall sign (with certification/license number) each sheet included in the set of drawings.

B. Installer: The field sprinkler foreman shall hold a current valid certification from a nationally recognized sprinkler apprenticeship school or government agency, or be recognized as "Journey Level" by a local fire sprinkler labor union. The installing contractor shall be licensed in the State of Maryland.

1.8 SUBMITTALS

A. General:

1. UMB requires all that all submittals, which includes shop drawings, product data, related equipment maintenance manuals, warranty documentation and all other pertinent information be submitted electronically by the manufacturer, trade contractors, and construction manager as a "pdf" file for review as required by Division 01. Partial submittals are not acceptable and will be returned without review.

2. After contract award and before material is ordered submit electronically all product data, shop drawings and other such descriptive data as the Engineer may require to demonstrate compliance with the contract documents as required by the contract clauses for review and approval.

3. Submittals shall include the manufacturer's name, trade name, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and paragraph reference, applicable publication references, years of satisfactory service, and other information necessary to establish contract compliance of each item the Contractor proposes to furnish.

4. Fire Protection Design shop drawings must be developed by computer software. Any hand drawn shop drawings will be rejected and will not be reviewed.

5. Submittals for Fire Stops and Smoke Seals required for the project shall be by the same manufacturer. Additional requirements shall be as indicated below:

   a. Submittals for Fire Stops and Smoke Seals shall include a certification from the manufacturer that each submitted product complies with the local regulations controlling the use of volatile organic compounds (VOC's) and or non toxic to the building.

   b. These submittals shall also include data, diagrams and details showing the UL assemblies to be installed.

6. Submittals will be reviewed for general compliance with design concept in accordance with contract documents, but dimensions, quantities, or other details will not be verified.

7. Submittals shall include the following items:
   a. Article 2.3, Fire Stops and Smoke Seals
   b. Article 2.4, Sprinkler System Pipe, Fittings, and Joints
   c. Article 2.5, Pipe Sleeves
   d. Article 2.6, Sprinklers
   e. Article 2.7, Identification and Leak Testing
   f. Article 2.8, Hangers and Supports

g. Article 2.9, As-Built Drawing
h. Article 2.10, O & M Manuals

8. Additional Submittals: Subject to project requirements, in addition to the submittals indicated above the following submittals may also be required:

a. Coordinated drawings
b. Samples

9. Submittal File Format: File formats and names for each submittal shall be electronically as follows:

a. File Formats:
1) Product Data: "pdf" file format.
2) Design Shop Drawings: "pdf" and "dwg" file formats.
3) Coordinated Drawings: "pdf" or "dwg" file formats.
4) Schedules: "xl" file format.

b. File Name: Division # - Article # & Title (R1, R2 etc.):
1) Example: 210000 – 2.3 Fire Stops and Smoke Seals
2) Example: 210000 – 2.4 Sprinkler System Pipe, Fittings, and Joints R1

10. Aside from the electronic submission, sprinkler shop drawings must also be submitted as a full-size hard copy to the UMB Fire Marshal. All requirements from the "Working Plans" Section of NFPA 13 must be met.

1.9 IDENTIFICATION BADGES

A. Contractors must obtain photo identification cards for all employees who will be at the construction site. The University will charge the contractor $25.00 for each badge as a deposit of which $20.00 will be returned when the badge is returned. Lost photo I.D. card will cost $25.00 for another replacement card. (The above charges are subject to change without notice.)

1.10 HAZARDOUS MATERIALS

A. Identification and removal of hazardous materials (asbestos, lead paint, PCBs) is not part of this contract. If questionable material is encountered, notify the University Project Manager and the University Environmental Health and Safety Department in writing immediately. The University shall then arrange for investigation and possible abatement of the material. Contractor shall schedule his work to accommodate hazardous material removal by the Owner.

1.11 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 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.

PART 2 – PRODUCTS:

2.1 LISTED MANUFACTURERS

A. The manufacturers indicated in Part 2 represent the basis for design and identify the minimum level of quality for materials and equipment, specified in this section, that are acceptable to UMB. Unless otherwise indicated in this 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.

2.2 GENERAL REQUIREMENTS

A. Sprinkler system design, installation and water supply requirements shall be designed to a minimum hazard classification of Ordinary Hazard (Group 1), unless otherwise approved by the UMB Fire Marshal.

B. All modifications to existing sprinkler systems shall be performed in accordance with the edition of NFPA 13 which is applicable within the State of Maryland at the time of contract execution and as approved by the UMB Fire Marshal.

C. The Contractor shall be responsible for replacing all products and material that were installed and not included in the approved submittal at zero expense to UMB.

2.3 FIRE STOPS & SMOKE SEALS

A. Provide fire stops and smoke seals for all new and existing fire protection piping in the project area that pass-through fire rated partitions, wall, floors 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 partition, wall, floor, 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 compromising the integrity of the sealed openings. Provide UL System Numbers and Details in product submittals for each fire stop & smoke seal application.

B. 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.

C. All fire stop and smoke seal materials shall be as manufactured by any one (1) of the following manufacturers:

1. Specified Technologies Inc. (STI)
2. DOW Corning Corp.
3. 3M Inc.
4. Hilti

2.4 SPRINKLER SYSTEM PIPE, FITTINGS, AND JOINTS

A. General: All pipe, fillings, joints and couplings used for standpipe and sprinkler systems shall be as follows:

1. Piping: All piping shall be the product of one (1) manufacturer. Acceptable manufacturer for sprinkler piping is Wheatland Tube Company or approved domestic equal.

2. Fittings, Couplings and Gaskets: All grooved fittings, couplings and gaskets shall be the product of one (1) manufacturer. Grooving tools shall be of the same manufacturer as the grooved components. Acceptable manufacturers for grooved fittings, couplings and gaskets are Victaulic or Gruvlok with Victaulic products as the basis of design.

B. Pipe Material: All piping shall be Grade A or Grade B, Schedule 40 black steel pipe manufactured in the United States as follows:

1. Piping one half (1-1/2) inch and smaller shall conform to Type ‘F’ Grade ‘A’ Schedule 40 black steel pipe per ASTM A53 with threaded ends. Threads shall be per ANSI B.1.20.1.

2. All two (2) inch piping shall conform to Type ‘E’ Grade ‘B’ Schedule 40 black steel pipe per ASTM A53. Two (2) inch piping shall be either thread end type per paragraph 1 above or rolled grooved end type per paragraph 3 below. (Contractor Option)

3. Piping two and one half (2-1/2) inch and larger shall conform to Type ‘E’ Grade ‘B’ Schedule 40 black steel pipe per ASTM A53 with rolled grooved ends.

C. Fitting Material: Comply with the following:

1. Fittings for piping one and one half (1-1/2) inch and smaller shall be threaded Class 125 cast iron fittings.

2. Fittings for two (2) inch piping shall be either threaded Class 125 cast iron per paragraph 1 above or ductile iron grooved end fittings per paragraph 3 below. (Contractor Option)

3. Fittings for piping two and one half (2-1/2) inch and larger shall be ductile iron grooved end fittings. Fittings shall be short pattern, with flow equal to standard pattern fittings.

D. Joints, Couplings and Gaskets: Comply with the following:

1. Joints:

a. Joints for piping one and one half (1-1/2) inch and smaller shall be Threaded Joints conforming to American Standard for Pipe Threads ANSI B2.1.

b. Joints for two (2) inch piping shall either be Threaded Joints per paragraph ‘a’ above or Rolled Groove Joints with Couplings per paragraph ‘c’ below. (Contractor Option)

c. Joints for piping two and one half (2-1/2) inch and larger shall be Rolled Groove Joints with Couplings.

2. Couplings:

a. Couplings for rolled grooved piping shall be Victaulic Quick Vic Rigid Coupling Style 107N 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.

b. Where seismic design requirements are applicable, provide Victaulic Quick Vic Flexible Coupling Style 177N.

3. Gaskets: Gasket Material shall be as follows:

a. Wet Systems: Grade ‘EHP’ EPDM.
b. Dry Systems: Grade ‘E’ Type ‘A’ EPDM.

2.5 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.

2.6 SPRINKLERS

A. General: Sprinklers shall be listed by UL and only new sprinklers shall be installed. Sprinklers shall be located and installed in accordance with NFPA 13 and properly coordinated with all other work.

B. Damage to Sprinklers: Any sprinkler that incurs damage, is painted, sprayed, caulked, or covered with any material before the system is accepted by the University shall be replaced by the contractor at no cost to the Owner. Protective sprinkler caps cannot be removed until after the ceiling is in place, or sprinklers will be subject to replacement.

C. Basis of Design: The basis of design shall be sprinklers manufactured by Viking or others as permitted below.

D. Temperature Ratings: The temperature rating of every sprinkler shall be in accordance with NFPA 13 and based upon the maximum anticipated ceiling temperature.

E. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler. Guards shall be specifically listed for the sprinkler on which they are being installed. Guards shall be installed wherever sprinklers are potentially subject to damage. Guards shall be installed on all upright sprinklers located at the base of stairwells, on all sprinklers under ductwork, and on all sprinklers installed less than six (6) feet – eight (8) inches above the finished floor.

F. Spare Sprinklers: The spare sprinklers 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. Provide spare quantities as follows:

Type of Sprinklers Installed:	Minimum Spare Sprinklers:
1-10	1
11-50	2
51-100	3
101-500	4
501+	6

In no case shall the total number of spare sprinklers provided be less than the number required by NFPA 13.

G. Coverage: Except for high hazard areas, all sprinklers shall be quick response standard coverage type sprinklers with a 'K' Factor of 5.6, unless prohibited by Code or otherwise directed by the UMB Fire Marshal. Only the listed sprinklers below may be installed, unless specific project requirements dictate a different type of sprinkler:

1. Upright Sprinklers: Where upright sprinklers are required, provide Viking VK300 - Microfast Quick Response Upright Sprinkler with a chrome finish.

2. Concealed Sprinklers: Where concealed sprinklers are required, provide Viking VK462 - Mirage Quick Response Concealed Pendent Sprinkler and escutcheon with a white finish to match ceiling and/or walls.

3. If existing to remain sprinklers are present in the same compartment as new sprinklers, the existing sprinklers are not one of the models specified above, the new sprinklers shall match the type and style of the existing sprinklers.

2.7 IDENTIFICATION, & PIPE HYDROSTATIC/LEAK TESTING

A. General: Provide all supports, identification, and hydrostatically leak testing for all piping systems indicated on the drawings, details and as specified below.

B. Identification Products for Fire Protection Systems: Identification products for fire protection systems shall include pipe labels and ceiling markers from one (1) of the following manufacturers or approved equivalent: as follows:

1. Seton Fire Protection Signage
2. Craft Mark Fire Protection Signage
3. Reliable
4. Tyco
5. Kroy

6. Pipe Labels: Provide printed plastic self-adhesive pipe labels with contact-type, permanent-adhesive backing with a directional flow arrow and pipe service.

   a. 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.
   b. Lettering Size:
      1) Pipe Size Less Than One and One Half (1-1/2) Inch in Diameter: Label shall be at least three quarter (3/4) inches high.
      2) Pipe Size One and One Half (1-1/2) Inch to Two Inch (2) in Diameter: Label shall be at least one and one half (1-1/2) inches high.
      3) Pipe Size Two and One Half (2-1/2) Inch in Diameter and Larger: Label shall be at least two and one quarter (2-1/4) inches high.

c. Pipe-Label Colors:

1) Background Color: Red.
2) Letter Color: White.
3) Lettering: (Wording for items B & C may need to be custom ordered)

a) "Fire Sprinkler"
b) "Pre-Action Fire Sprinkler"
c) "Drain"
d) "Standpipe"

C. 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 valves and sprinkler system components.

1. Ceiling Marker Data: For Fire Protection printed data shall be as follows:

a. FP Valve – Low Point Drain.

D. Pipe System Hydrostatic/Leak Test:

1. Perform hydrostatic testing in accordance with NFPA 13.

2.8 HANGERS AND SUPPORTS

A. Provide hangers and supports in compliance with NFPA 13.

2.9 AS BUILT DRAWINGS

A. For requirements see Part 3.

2.10 OPERATION AND MAINTENANCE MANUAL ELECTRONIC FILES

A. Fire Protection O & M Manual File: Provide one (1) electronic file "pdf format" for the Material and Equipment included in Division 21. The electronic file shall include one (1) copy of each approved submittal, any manufacturer's maintenance manuals, and 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 Closeout Procedures.

PART 3 - EXECUTION:

3.1 GENERAL REQUIREMENTS

A. In no case shall the existing fire protection system be placed out of service for more than eight (8) hours in a twenty four (24) hour period without the written approval of the UMB Fire Marshal. Contractor shall be responsible for performing a fire watch for outages greater than eight (8) hours.

B. Install all pipe, fittings, valves, controls, hangers and other components in accordance with NFPA 13.

C. 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.

D. All construction work that creates excessive noise will not be permitted during normal business hours. See Division 01 Specification Section 01045 “Cutting and Patching” for requirements.

3.2 CONNECTIONS AND ALTERATIONS TO EXISTING WORK

A. When existing fire protection work is removed, all pipes, valves, fittings, etc. shall be removed back to the active mains and capped. Plug and remove existing piping at the last active sprinkler.

B. Removal and/or relocation of existing services shall be closely coordinated with Facilities Management if they impact adjacent areas which shall remain operational.

C. While performing connections and alterations to existing fire protection work, the contractor shall take extreme care to protect all existing materials, equipment, casework etc. from dirt, debris, and damage. Any damage caused by the contractor to existing materials, equipment, casework, etc. shall be repaired to UMB's satisfaction and specifications at the contractor's expense.

3.3 CUTTING AND PATCHING

A. Cutting and patching associated with the work in the existing structure shall be performed a neat and workmanlike manner. Existing surfaces that are damaged by the contractor shall be repaired or provided with new materials to match existing.

B. Structural members shall not be cut or penetrated. Holes cut through concrete and/or masonry to accommodate new work shall be cut by reciprocating or rotary, non-percussive methods.

C. Patching of areas disturbed by installation of new work and/or required demolition shall match existing adjacent surfaces as to material, texture and color.

3.4 CUTTING, WELDING, BURNING

A. Before the contractor and/or any sub-contractor commences any cutting, welding, burning, brazing (pipe sweating), or any other type of work the contractor shall obtain a hot work permit from Environmental Health and Safety Department at extension 1-410-706-3494 or 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.

3.5 INSTALLATION – PIPE SLEEVES

A. Non-Fire-Rated Sound Proof Partition Penetrations: Where pipes pass through interior partitions with sound proofing provide pipe sleeves. Seal the annular spaces between construction openings, the sleeves, and pipes with sound proof insulation material equal to the width of the opening. The sound proof insulation shall match the insulation in the partition.

3.6 INSTALLATION – SPRINKLER PIPING

A. In areas with suspended ceilings all sprinkler piping shall be concealed. Piping shall be installed and arranged to protect it from freezing and corrosion, and shall be pitched for drainage.

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. Install all vertical sprinkler piping systems level and parallel to the building walls, ceilings, and partitions.

D. Where horizontal sprinkler piping offsets to clear obstructions such as ductwork, structural members and work installed by other trades provide low point drain valves in locations where they can be accessed.

3.7 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.

3.8 INSTALLATION – SPRINKLERS

A. Center sprinklers in ceiling tiles and coordinate location with all other trades, including but not limited to ceilings, lights, diffusers, grilles etc.

B. Sprinklers shall be installed using rigid pipe offsets, or return bends for the sprinkler drops. Where rigid pipe offsets, return bends are used for the sprinkler drop, the connection to the drop must be off of the top of the pipe.

C. In finished areas where more than two (2) sprinklers are installed, the deflectors of all sprinklers shall be installed at the same elevation from the finished floor.

3.9 INSTALLATION – PIPE LABELS

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

B. Clean piping and equipment surfaces of substances that could impair bond of identification devices which may include dirt, oil, grease, release agents, incompatible primers, paints, and encapsulants.

C. Pipe Labels: Provide pipe labels for all exposed and concealed piping. Locate pipe labels as follows:

1. In spaces without ceilings position pipe labels so they are visible from the floor.
2. In concealed spaces above suspended ceilings and in utility shafts position pipe labels so they are visible from an access point.
3. Spaced at maximum intervals of twenty-five (25) feet along each run of the sprinkler main.
4. Near the midpoint of each branch pipe serving more than one (1) sprinkler.

3.10 INSTALLATION, TEST AND ACCEPTANCE

A. Installation, Tests, And Acceptance:

1. Installation, testing, and final acceptance shall be in accordance with all applicable codes, and the requirements of the University and the UMB Fire Marshal.

2. All required test shall be performed by the fire protection contractor as part of this contract. The fire protection contractor shall see that proper representatives of the Owner, the Engineer, UMB Fire Marshal, Office of Facilities Management and any other personnel desiring to witness the tests shall be notified at least five (5) days prior to the scheduled test time.

3.11 CONSTRUCTION RECORD DOCUMENTS

A. The sprinkler contractor shall not deviate from the approved sprinkler layout drawings unless written approval has been obtained from the UMB Fire Marshal.

B. Where deviations are approved by the UMB Fire Marshall or as necessary by field conditions, 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 sprinkler layout drawings. When the sprinkler work has been completed and accepted by UMB and all deviations have been recorded the sprinkler contractor shall scan the prints as a color pdf file.

C. Upon completion of the work, the sprinkler contractor shall transmit to the A/E one (1) set of marked up prints as a colored pdf file and one (1) electronic CAD file in Auto Cad Release 2016 or latest edition with All "As Built Drawing" information neatly recorded thereon in red. The A/E shall verify that all “Record Drawing” information has been recorded on the electronic CAD file. The electronic CAD file and mark up pdf file shall be transmitted to UMB by the A/E.

D. At a minimum, the following installed conditions shall be recorded:

1. Location of all low point drain valves with assigned valve tag numbers.

3.12 CLEAN – UP

A. Excessive debris and dirt, such as occurs from cutting through masonry or plaster walls shall be cleaned up from the equipment and removed immediately after the work of cutting through the walls.

B. Debris shall be removed from UMB property.

C. Ceiling Tiles: Ceiling tiles in finished areas shall not be installed/replaced until all inspections have been completed and accepted.

D. All areas shall be left broom-clean at the end of the work period.

3.13 COMPLETED HYDROSTATIC/LEAK TEST FORMS

A. Upon completion of each hydrostatic/leak test, the contractor shall upload the signed leak test forms to the Project File, in ebuilder, in Folder 11.06 Test Reports.

3.14 UMB STANDARD HYDROSTATIC/LEAK TEST SUMMARY FORMS

A. General: Contractor shall use the "UMB Standard Pipe System Hydrostatic/Leak Test Summary Form.

1. Sample Form: The following page contains a sample of the UMB Standard Pipe System Hydrostatic/Leak Test Summary Form.

2. Availability: The standard test summary form is available on the UMB Web Site at http://www.umaryland.edu/designandconstruction/, under the "Documents" link.

UMB STANDARD PIPE SYSTEM HYDROSTATIC/LEAK TEST SUMMARY FORM

TEST DATA:

Date: _____ Project Number: _____

Location: _____

Pipe System Tested (Service): _____

Location and Description: _____

Pipe Materials: _____

Operating Pressure: _____

Specified Test Pressure: _____

Actual Test Pressure: _____

Pressure Test Type: _____

Test Start Time: _____ Recorded Test Pressure: _____

Test Completion Time: _____ Recorded Test Pressure: _____

Test Duration: _____ Pressure Drop or Rise: _____

Test Result (Pass/Fail): _____

SIGNATURES:

Construction Manager: _____

Construction Manager Representative: _____

Mechanical Contractor: _____

Mechanical Contractor Forman: _____

UMB Division: _____

UMB Witness: _____

Remarks: _____

END OF SECTION 210000

DIVISION 230000 – HVAC

PART 1 - GENERAL:

1.1 RELATED DOCUMENTS

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

1.2 SCOPE

A. The mechanical contractor shall furnish all labor, material, tools, equipment and services necessary and incidental for installing all mechanical systems shown on the drawings, indicated in the specification, or necessary to provide a finished installation. The finished installation shall be in perfect working condition and be ready for continuous and satisfactory operation. The project area is located in UMB BRB Penthouse and 14th Floor.

1.3 CODES AND REGULATIONS

A. All materials furnished and all work installed shall comply with the codes and regulations adapted by the State of Maryland and recommendations of the following bodies:

1. International Building Code (IBC)
2. International Mechanical Code (IMC)
3. International Plumbing Code (IPC)
4. National Electric Code (NEC)
5. Maryland State Health Department
6. Underwriters Laboratories (UL)

1.4 RESPONSIBILITY

A. The Construction Manager/General Contractor (CM/GC) shall be responsible for all work included in the Mechanical Division. The delegation of work to the contractors shall not relieve him of this responsibility. Contractors who perform work under these sections shall be responsible to the CM/GC.

1.5 SITE VISIT

A. Prior to preparing the bid, the HVAC contractor shall visit the site and become familiar with all existing conditions. Make all necessary investigations as to locations of utilities and existing field conditions that could 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 contractor shall submit an outage request to the University of Maryland, Baltimore (UMB) Project Manager, using the UMB Standard Request for Outage Form which is available through the UMB Web Site at http://www.umaryland.edu/designandconstruction/, under the "Documents" link. The existing mechanical/electrical/fire protection systems 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 business days (10) days in advance with the UMB Design and Construction Department. Outages shall be performed during normal duty hours. If necessary, some outage work may be performed outside normal hours if approved by UMB.

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 UMB Design and Construction Department.

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 operated by University personnel only. Unauthorized operation of HVAC valves, power switches, by contractors and their personnel will result in extremely serious consequences for which the contractor will be held accountable.

1.7 SUBMITTALS

A. General:

1. UMB requires all that all submittals, which includes shop drawings, product data, related equipment maintenance manuals, warranty documentation and all other pertinent information be submitted electronically by the manufacturer, trade contractors, and construction manager as a "pdf" file for review as required by Division 01. Partial submittals are not acceptable and will be returned without review.

2. After contract award and before material is ordered submit electrically all product data, shop drawings and other such descriptive data as the Engineer may require

to demonstrate compliance with the contract documents as required by the contract clauses for review and approval. All construction and administrative type submittals shall be transmitted through ebuilder to the A/E Team and UMB.

3. Submittals shall include the manufacturer's name, trade name, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and paragraph reference, applicable publication references, years of satisfactory service, and other information necessary to establish contract compliance of each item the Contractor proposes to furnish.

4. HVAC shop drawings must be developed by computer software. Any hand drawn shop drawings will be rejected and will not be reviewed.

5. Submittals for Fire Stops and Smoke Seals required for the project shall be by the same manufacturer. Additional requirements shall be as indicated below:

   a. Submittals for Fire Stops and Smoke Seals shall include a certification from the manufacturer that each submitted product complies with the local regulations controlling the use of volatile organic compounds (VOC's) and or non toxic to the building.

   b. These submittals shall also include data, diagrams and details showing the UL assemblies to be installed.

   c. Engage a technician who has installation experience, using the approved materials, to provide training to the various trade personnel who will install the materials required for the project. Training period shall be for four (4) hours. Submit a Certificate of Training from the manufacturer of the material to the UMB Project Manager documenting the required training.

6. Submittals will be reviewed for general compliance with design concept in accordance with contract documents, but dimensions, quantities, or other details will not be verified.

7. Submittals shall include the following items:
   a. Article 2.2, Fire Stops and Smoke Seals
   b. Article 2.3, HVAC Piping Systems
   c. Article 2.4, Pipe Sleeves
   d. Article 2.5, Piping Specialties
   e. Article 2.8, HVAC Valves
   f. Article 2.9, Hangers and Supports
   g. Article 2.10, Identification System

h. Article 2.13, HVAC A/C Equipment
i. Article 2.14, Ductwork and Accessories
j. Article 2.15, HVAC Insulation
k. Article 2.16, BAS
l. Article 2.17 TAB Report
m. Article 2.18, O & M Manual

8. Additional Submittals: Subject to project requirements, in addition to the submittals indicated above the following submittals may also be required:

   a. Coordinated drawings

9. Submittal File Format: File formats and names for each submittal shall be electronically as follows:

   a. File Formats:
      1) Product Data: "pdf" file format.
      2) Design Shop Drawings: "pdf" and "dwg" file formats.
      3) Coordinated Drawings: "pdf" or "dwg" file formats.
      4) Schedules: "xl" file format.

   b. File Name: Division # - Article # & Title (R1, R2 etc.):
      1) Example: 230000 – 2.2 Fire Stops and Smoke Seals
      2) Example: 230000 – 2.3 HVAC Piping Systems R1

1.8 SAMPLES

A. Samples of materials to be used on the work shall be submitted when requested and shall be subject to approval by the A/E and the UMB Design and Construction Department.

1.9 IDENTIFICATION BADGES

A. Contractors must obtain photo identification cards for all employees who will be at the construction site. The University will charge the contractor $25.00 for each badge as a deposit of which $20.00 will be returned when the badge is returned. Lost photo I.D. card will cost $25.00 for another replacement card. (The above charges are subject to change without notice.)

1.10 HAZARDOUS MATERIALS

A. Identification and removal of hazardous materials (asbestos, lead paint, PCBs) is not part of this contract. If questionable material is encountered, notify the University Project Manager and the University Environmental Health and Safety in writing immediately. The University shall then arrange for investigation and possible abatement of the

material. Contractor shall schedule his work to accommodate hazardous material removal by the Owner.

1.11 COMMISSIONING MECHANICAL SYSTEMS

A. Summary: This section includes the requirements for commissioning new HVAC Systems, assemblies and equipment related to the project area.

B. Commissioning Agent (CxA): The CxA for the project shall be as assigned by UMB.

C. Description: The following equipment and/or accessories shall be commissioned as part of this project:

1. HVAC Systems:

a. Air Distribution Systems:

b. HVAC Equipment:

1) Supplemental A/C units.

c. BAS:

1) Local control components for installed equipment.
2) Integration into campus system.
3) Project graphics and programming.

1.12 MOTOR REQUIREMENTS

A. General Requirements:

1. Compliance: Comply with NEMA MG 1 unless otherwise indicated.

2. Motor Requirements: Requirements below apply to motors covered by this Section except as otherwise indicated.

a. Motors 1/2 HP and Larger: Three phase.
b. Motors smaller than 1/2 HP: Single phase.
c. Frequency Rating: 60 Hz.
d. Voltage Rating: Determined by voltage of circuit to which motor is connected for the following motor voltage ratings (utilization voltages):

1) 120 V Circuit: 115 V - motor rating.
2) 208 V Circuit: 200 V - motor rating.

3) 240 V Circuit: 230 V - motor rating.
4) 480 V Circuit: 460 V - motor rating.

3. 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.
4. 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.
5. Temperature Rise: Based on 40ºC ambient except as otherwise indicated.
6. Enclosure: Open drip proof, unless otherwise specified. Provide screen over slots, where slots will permit passage of human extremities.
7. Provide adjustable motor slide base for belt driven equipment. Include adjusting bolts and locknuts.

B. Three Phase Motors:

1. Description: NEMA MG 1, Design B, medium induction motor.
2. 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

3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.

a. For motors with 2:1 speed ratio, consequent pole, single winding.
b. For motors with other than 2:1 speed ratio, separate winding for each speed.

5. Rotor: Random-wound, squirrel cage.
6. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
7. Temperature Rise: Match insulation rating.
8. Insulation: Class F.
9. Code Letter Designation:

a. Motors 15 HP and Larger: NEMA starting Code F or Code G.

b. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

10. 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.

C. Polyphase Motors With Additional Requirements:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

2. Motors Used with Variable Frequency Controllers: Motor ratings, characteristics, and features shall be coordinated with and approved by controller manufacturer.

a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
b. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

D. Single Phase Motors:

1. Motors larger than 1/20 hp shall be one (1) of the following, to suit starting torque and requirements of specific motor application:

a. Permanent-split capacitor.
b. Split phase.
c. Capacitor start, inductor run.
d. Capacitor start, capacitor run.

2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 HP and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

1.13 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 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 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. The manufacturers indicated in Part 2 represent the basis for design and identify the minimum level of quality for materials and equipment, specified in this section, that are acceptable to UMB. Unless otherwise indicated in this 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.

2.2 FIRE STOPS & SMOKE SEALS

A. Provide fire stops and smoke seals for all new and existing HVAC piping 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 partition, wall, floor, 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 UL System Numbers in product submittals for each fire stop & smoke seal application.

B. 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.

C. All fire stop and smoke seal materials shall be as manufactured by any one (1) of the following manufacturers:

1. Specified Technologies Inc. (STI)
2. DOW Corning Corp.
3. 3M Inc.
4. Hilti

2.3 HVAC PIPING SYSTEMS

A. General: Provide all piping systems indicated on the drawings and as specified below, including all labor materials and equipment necessary for a complete installation.

B. HVAC Piping Systems: HVAC piping systems include steam, condensate and hydronic piping systems as follows:

1. Hydronic Water Piping Systems: Hydronic water piping systems include, Heating Hot Water, Condenser Water, Chilled Water, Process Cooling Water, and Energy Recovery (Glycol) Water Systems. Pipe, fittings and joints shall be as follows:

a. Solder Connection: Hydronic water piping two (2) inch and smaller shall be type 'L' copper tubing assembled with wrought copper fittings and 95-5 solder.

b. Press End Connection: Hydronic water piping two (2) inch and smaller shall be type 'L' copper tubing assembled with Viega ProPress copper fittings with EPDM seals and press connection with EPDM sealing. (Contractor Option)

2. A/C Condensate Drain Piping:

a. A/C condensate drain piping shall be schedule 40 PVC pipe and fittings.

b. A/C condensate drain piping shall be type 'L' copper tubing assembled with wrought copper fittings and 95-5 solder. (Contractor's option)

2.4 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.

2.5 PIPING SPECIALTIES

A. General: Provide all piping specialties where indicated on the drawings, details, and as specified below complete with all supports, fittings, etc. for HVAC Piping Systems.

B. Piping Specialties:

1. Manual Air Vents: Crane # 2910H, one quarter (1/4) inch Brass Cock
2. Pressure/Temperature Plugs: Peterson Equipment Co., one quarter (1/4) inch solid brass fitting w/ nardel valve core.

3. Strainers:

   a. Copper Piping (two (2) inch and smaller): Mueller Model 352M, 250 psig working pressure; cast bronze body with threaded ends, conforming to ASTM B 61, and perforated 20 mesh Type 304 stainless steel screen, blow-down drain with plugged valve and threaded hose connection.

4. Thermometer: Trerice adjustable type thermometer with seven (7) inch aluminum case, temperature range to suite system. Insertion length shall suite installation requirements.

   a. Service and Scale Range:

      1) HVAC Systems:
         a) Process Water: 0ºF to 100ºF, with two (2) degree scale divisions.

5. Pressure Gauges: Trerice Type 450 series, four and one half (4-1/2) inch diameter case, one quarter (1/4) inch brass socket, #735 – two (2) needle valve, pressure range suite system. Gauges shall have black letters on white background. On gauges used for steam service provide a Trerice #885-1 coil syphon for each gauge.

   a. Service and Scale Range in pounds per square inch (PSI):

      1) HVAC Systems:
         a) HVAC Water Systems: Zero (0) to two (2) times operating pressure.

6. Flexible Connections: Metraflex flexible pipe connectors with stainless steel hose and braid, and copper end tubes, or schedule 40 IPS pipe ends.

7. Pipe Alignment Guides: Metraflex style one (1) pipe alignment guide. Anchor guides to building structure.

8. Pipe Anchors: Anchors shall be constructed of steel sections and plates, assembled by bolting or welding and secured to building structure.

9. Dielectric Connections: Provide dielectric connections where nonferrous metal is joined to ferrous metal as follows:

   a. Piping Two (2) Inch and Smaller: Provide type 316 stainless steel nipples, four (4) inches long with thread ends.

2.6 HVAC VALVES

A. Shut Off, Drain and Specialty Valves: All Shut Off, Drain and Specialty Valves installed in HVAC Hydronic Piping Systems shall be as specified below. Gate Vales will not be permitted for installation in these systems. All valves used in hydronic systems shall be Lead Free Certified per NSF/ANSI 61 and NSF/ANSI 372. Only listed manufacturers and model numbers below are acceptable to UMB.

   1. Shut Off Valves for Hydronic Solder Joint Piping Systems:

      a. Shut Off Valves for Piping Systems One Half (1/2) Inch through Two (2) Inch: All valves used for shut off duty shall be two (2) piece full port (FP) lead free valves with brass or bronze valve body with threaded end connections, solid tunnel bore 316 stainless steel ball and stem, modified teflon double seal seats and teflon seals, and valve handle. Valve model numbers shall be as listed below:

         Apollo: 77FLF-140* Series, Brass Body.
         Milwaukee: UPBA400S* Series, Bronze Body.
         Watts: LFB6080G2-SS*, Brass Body.

      b. Contractor Note: Branch piping and associated shut off valves for terminal unit reheat coils shall not be less than three quarter (3/4) piping.

         *Provide stem extensions on valves used in cold water service (i.e., cold water, chilled water, etc.).

   2. Shut Off Valves for Hydronic ProPress (Press End) Piping Systems: (Contractor Option)

      a. Shut Off Valves for Piping Systems One Half (1/2) Inch through Two (2) Inch: All valves used for shut off duty shall be two (2) piece full port lead

free valves with brass or bronze valve body with smart end connections, solid tunnel bore 316 stainless steel ball and stem, EPDM seats and teflon seals, and valve handle. Valve model numbers shall be as listed below:

Viega – 2971.1ZL* Bronze Body
Apolloxpress – 77WLF-140* Bronze Body
Milwaukee – UPBA480S* Brass Body

*Provide stem extensions on valves used in cold water service (i.e., cold water, chilled water, etc.).

3. Drain and Specialty Valves for Hydronic Piping Systems:

a. Drain Valves for Piping Systems One Half (1/2) Inch to Two (2) Inch: All valves used as low point drains or for system drain down duty shall be three quarter (3/4) inch two (2) piece full port (FP) lead free valves with brass or bronze valve body with threaded end connections, solid tunnel bore 316 stainless steel ball and stem, modified teflon double seal seats and teflon seals, valve handle and three quarter (3/4) inch capped hosed connection. Valve model numbers shall be as listed below:

Apollo: 77FLF-140* Series, Brass Body.
Milwaukee: UPBA400S* Series, Bronze Body.
Watts: LFB6080G2-SS*, Brass Body.

b. Drain Valves for Piping Systems two and One Half (2-1/2) Inch and Larger: All valves used as low point drains or for system drain down duty shall be two (2) inch two (2) piece full port (FP) lead free valves with brass or bronze valve body with threaded end connections, solid tunnel bore 316 stainless steel ball and stem, modified teflon double seal seats and teflon seals, valve handle and two and one half (2-1/2) inch capped hosed connection. Valve model numbers shall be as listed below:

Apollo: 77FLF-140* Series, Brass Body.
Milwaukee: UPBA400S* Series, Bronze Body.
Watts: LFB6080G2-SS*, Brass Body.

c. Specialty Valves: All specialty valves used for Pressure Gages, P/T Plugs, and DP Switches shall be one quarter (1/4) inch two (2) piece full port (FP) lead free valves with brass or bronze valve body with threaded end connections, solid tunnel bore 316 stainless steel ball and stem, modified teflon double seal seats and teflon seals, and valve handle. Valve model numbers shall be as listed below:

Apollo: 77FLF-140* Series, Brass Body.
Milwaukee: UPBA400S* Series, Bronze Body.
Watts: LFB6080G2-SS*, Brass Body.

2.7 HANGERS & SUPPORTS

A. General: Provide all supports, identification, and testing for all piping systems indicated on the drawings, details and as specified below.

B. Interior Pipe System Hangers & Supports:

1. Hangers and supports shall be provided for all piping systems, as recommended by the hanger manufacturers for the existing structural elements. On piping systems requiring insulation, hangers and supports shall be installed external to the insulation material, and sheet metal saddles shall be provided. Hangers and supports shall be provided at all changes of direction and elevations on piping system. Spacing shall be as recommended by manufacturer, for each pipe size and material.

2. Hangers, Supports, and Components: Provide factory fabricated products according to MSS SP-58 as manufactured by B-Line, Fee and Mason, ITT Grinnel, Pipe Shields, Inc., Michigan Hanger, and Unistrutt. Unless otherwise indicated, specified model numbers are manufactured by B-Line.

3. Components include galvanized coatings where installed for piping and equipment that will not have a field-applied finish.

4. Pipe attachments include nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

5. Thermal Hanger Shield Inserts: 100-psi (690kPa) average compressive strength, waterproofed calcium silicate or treated lumber inserts, encased with sheet metal shield. Insert and shield cover entire circumference of pipe and are of length indicated by manufacturer for pipe size and thickness of insulation.

6. Insulated Horizontal Piping Hangers: Chilled Water, Condenser Water, Steam and Condensate Return, Reheat Water, Glycol Solution, Heating Hot Water:

a. Two (2) inch and smaller: Figure No. B3108, with metal shield, Figure No. B3151.

b. Two and one-half (2-1/2) inch and larger: Figure No. B3108, with metal shield, Figure No. B3151.

7. Vertical Piping Riser Clamps:

a. Copper Pipe: Figure No. B3373CT.
b. Steel Pipe: Figure No. B3136 and B3137.

2.8 IDENTIFICATION SYSTEM

A. Identification Products for Mechanical Systems: Identification products for mechanical systems shall include pipe markers, duct markers, valve tags and schedule, and ceiling markers as follows:

1. Pipe Labels: Provide factory fabricated flexible, preformed semi-rigid plastic pipe labels to fit around pipe and/or pipe coverings, with fluid being conveyed and flow direction arrow. Pipe labels shall be SETMARK System as manufactured by Seton Name Plate Corporation or approved equal.

a. HVAC: Text with Field/Letter color as noted below
1) "PROCESS COOLING WATER SUPPLY" – Yellow/Black
2) "PROCESS COLING WATER RETURN" – Yellow/Black

2. Duct Stencil Labels: Provide duct stencil labels with the following designations and letter color:

a. Supply Air Duct: "Supply Air Duct – AHU – #"
b. Return Air Duct: "Return Air Duct – AHU-#"

3. Valve Tags:

a. Description: Stamped or engraved with one quarter (1/4) inch letters for piping system abbreviation and one half (1/2) inch numbers with:

1) Brass Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2) Fasteners: Brass wire-link chain.
3) Asterisk (*): Indicates the valve is part of a renovation project in the building.

b. HVAC: Service – Tag Data
1) Secondary Process Cooling Water Supply – *SPCWS
2) Secondary Process Cooling Water Return – *SPCWR

2.9 HVAC A/C EQUIPMENT

A. HVAC Equipment – Supplemental A/C Units:

1. Ceiling Mounted DX Water Cooled A/C Unit:

a. General: Furnish and install Horizontal Ducted Straight Through mounted packaged water cooled A/C Units as manufactured by Above Air Technologies or approved equal. Units shall be provided with factory furnished and installed microprocessor controls. Additionally, the unit shall be furnished with software communications interface capability for connectivity to the external Building Automation System through Bac Net IP Protocol. See the drawings for unit location and capacity.

b. Unit Configuration: Unit configuration shall be as follows:
1) Ducted Configuration: Unit shall be provided with one (1) inch flanged duct connections for supply and return ductwork.

c. Unit Construction:

1) Unit Casing: Unit casings shall be constructed with 0.062 inch aluminum panels and supported by internal three sixteenths (3/16) inch aluminum frames. Casing shall be lined with one half (1/2) inch thick, two (2) pound per cubic foot density insulation protected from erosion. The internal condensate drain pan shall be constructed of 20 gauge stainless steel with drain connection on the same end as the pipe connections for the water cooled condenser. Provide removable access panels for access to fans, filters, coils, compressors and refrigeration components.

2) Fan Types: Fan type shall be as follows:
a) Direct Drive ECM Fan/Motor (12-15 Ton Units): Plug Fan with backward curved impeller made of aluminum (AlMg3) with seven (7) backward curved blades and efficiency optimized circumferential diffuser. Sound optimized. Pressure orientated behavior. Fluidic optimized inlet cone made of galvanized sheet metal. Motorized Impeller, includes motor and impeller. Fitting fluidic optimized cone available. Mounting either with horizontal or vertical motor shaft. Motorized Impeller shall be statically and dynamically balanced according to DIN ISO

21940-11 at least with quality level G6.3. Energy saving EC external-rotor motor of the 3rd generation. Maintenance free ball bearings, closed on both sides with long-term lubrication. Magnets without rare earth elements. Motor made of die casted aluminum. Protection Class IP54. Electronic with integrated terminal box and environmental resistant cable glands (2x M16 and 1x M20). Status LED integrated. 100% speed controllable with integrated motor protection. Soft Start. Potential-free Alarm Contact and integrated 24V Supply for Accessories. ModBus RTU Interface integrated. Busconfiguration possible on site by customer. Applicable in all common energy grids and IT-Network. Low noise commutation.

3) Evaporator System: Evaporator system shall be configured for a draw through air pattern to provide uniform air distribution over the evaporator coil face. Coils shall be constructed of seamless drawn copper tubes, mechanically bonded to tempered aluminum fins with a raised lanced fin design for maximum heat transfer. Coil end plates shall be hot dipped galvanized steel. The evaporator coil shall be mounted in a stainless steel condensate drain pan.

4) Filters: Filters shall be as follows:

a) Filter - Ducted Configuration: Filter shall be a one (1) inch deep class 2 filter per U.L. Standard 900 and shall also have a rating of at least 80% average arrestance as measured by ASHRAE Standard 52-76 test method. Filter shall be mounted inside the unit, in a filter rack, in front of the evaporator coil and shall be accessible through an access door in the side of the unit.

5) Refrigeration System: The refrigeration system shall include dual compressors, mounted on vibration isolators, type 'L' copper refrigeration tubing with brazed fittings, sight glass, externally equalized expansion valve, and liquid line filter dryer. The refrigeration system shall be pre charged with HCFC – 407-C refrigerant. The water cooled condenser shall be a tube in tube counter flow condenser rated for 150 psi.

6) Adjustable Water Regulating Valve: Adjustable water regulating valve by manufacturer to maintain head pressure with process cooling water conditions of 70ºF EWT/ 90ºF LWT. Include GPM and unit pressure drop in feet in the submittal data.

7) Control Panel: Unit mounted pre-wired control panel shall include contactors, relays, control transformer, capacitors, high and low refrigerant pressure switches, compressor and fan automatic reset safety devices for a complete control system.

8) Unit Power Supply: Single Source power supply shall be as follows:

   a) Four (4) Tons and Larger: 480 volt three phase.

9) Provide a MC-2000 Advanced Microprocessor controller with alarms, for each water cooled A/C unit, with a Bac Net IP serial card. Inputs and outputs shall be remotely monitored (address readable) through the BAS. The following I/O addressable points shall be included:

   a) Unit on/off
   b) Compressor running Module1
   c) Fan running Module1
   d) Compressor low pressure alarm Module1
   e) Compressor high pressure alarm Module1
   f) Air flow alarm Module1
   g) Water detector alarm Module1 (condensate pan)
   h) Room temperature to high alarm
   i) Room temperature to low alarm
   j) Supply temperature to high alarm
   k) Supply temperature to low alarm
   l) Water temperature to high alarm
   m) Water temperature to low alarm
   n) Set point temperature
   o) Set point supply air temperature
   p) Actual return air temperature
   q) Supply air temperature

10) Accessories: Accessories shall include the following:

   a) Over Flow Safety Switch: A condensate pan water level switch shall be incorporated to shut the system down if an overflow condition is sensed.

   b) Supply Air Temperature Sensor/Monitor: Provide a supply air temperature sensor for field installation in the supply air grille and wired through the E2 controller to the BAS.

Sensor shall only monitor the supply air temperature with a signal to BAS.

c) Remote Water/Leak Detector (Ducted Units Only): Where auxiliary drain pans are indicated provide a remote strip/cable type water/leak detector with a twenty (20) foot sensing cable for remote field installation. Also include a 24 volt water detector power module shall require field mounting and wiring to the factory provided terminal connection, providing a remote notification of water detection alarm. Upon sensing a water leak, the normally closed water detector control circuit shall open, thereby shutting down the unit's water producing components.

2.10 DUCTWORK AND ACCESSORIES

A. HVAC Material - Sheet Metal Ductwork and Accessories:

1. Sheet Metal Duct Work:

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. Seal Class: Except as otherwise indicated, all ductwork shall be constructed to meet the requirements of SMACNA Seal Class A. Conform to the requirements in the referenced construction for metal thickness, reinforcing types and intervals, tie rod applications, and joint types and intervals.

c. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for the pressure classification as follows:

1) Supply and Return Ducts - Downstream of A/C Units: 2-inch wg. (Low Pressure)

d. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

e. Cross Breaking or Cross Beading: Cross break 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.

f. Rectangular Duct Fittings: Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," Latest Edition.

g. Flexible duct work will be permitted at UMB provided the duct lengths do not exceed six (6) feet in length and are installed without sharp bends. Also Flex duct will be limited to connecting ceiling diffusers to branch ducts.

h. All sheet metal seams in new ductwork shall be sealed with mineral impregnated woven fiber tape as manufactured by Hardcast, Inc or other types of sealant materials.

i. Duct Connection Joint Sealant: Where new ductwork connects to existing ductwork provide the following material as a joint sealer between the new and existing duct surfaces:

a) 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.

j. Manual Volume Dampers: Provide manual volume dampers where shown on drawings and/or where needed for system balancing. Dampers shall be opposed blade type as specified below. Volume dampers shall be constructed of 16 gauge galvanized steel formed into structural hat channel shape with tabbed corners for reinforcement. Damper blades shall be opposed blade type single skin 16 gauge galvanized steel with three longitudinal grooves for reinforcement. Bearings shall be corrosion resistant, molded synthetic sleeve type turning in an extruded hole in damper frame. Axles shall be square or hexagonal positively locked into the damper blade. Dampers shall come with locking hand quadrant. Where ductwork is insulated provide a two (2) inch standoff mounting bracket for hand quadrant. Damper assembly shall be Model MD 35 as manufactured by Ruskin or approved equal.

k. Miscellaneous Sheet Metal: Fabricate and install an auxiliary drain pan under each Water Source DX Condensing Unit. Pans shall be made from galvanized sheet metal and have a thickness of not less than 0.0236 inches (No. 24 gauge). Drain pans shall have a depth of not less than 1-1/2 inches,

and be sized to at least 90" x 85" or not less than 3 inches larger than the Condensing Units. A one-inch drain connection shall be installed in each Auxiliary Drain Pan. Each drain pan shall be equipped with a water level detection device conforming to UL 508 that will shut off the condensing unit served prior to overflow of the pan.

2. Factory Fabricated Round Duct – Medium Pressure:

   a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the manufacturers specified:

      1) McGill Air Flow Corporation.
      2) SEMCO Incorporated.

   b. Round, Longitudinal- and Spiral Lock-Seam Ducts: Factory-fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards-Metal and Flexible." Fabricate ducts larger than seventy two (72) inches (1830 mm) in diameter with butt-welded longitudinal seams.

   c. Duct Joints:

      1) Ducts up to twenty (20) Inches (500 mm) in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.

   d. Tees and Laterals: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards-Metal and Flexible," with metal thicknesses two gauge numbers heavier than specified for longitudinal-seam straight ducts.

   e. Elbows: Use die-formed, gored, pleated, or mitered construction with bend radius of one and one half (1-1/2) times duct diameter. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards-Metal and Flexible," with metal thickness two gauge numbers heavier than specified for longitudinal- seam straight ducts.

   f. Branch Duct Connections: Provide branch duct connections for the following:

      1) Round Connections: Where round ducts connect to medium pressure mains provide conical connections.
      2) Non Round Connections: Where rectangular/square ducts connect to medium pressure mains provide connections with a 45 degree angle equal to the SMANCA "45 degree entry" fitting.

3) Rectangular/Square Manual Dampers: Where rectangular/square manual volume dampers connect to low pressure ductwork provide with a 45 degree angle,
4) Round Manual Dampers: Where round manual volume dampers connect to low pressure ductwork provide conical side tap connections.
5) Round Manual Dampers: Where round manual volume dampers connect to low pressure ductwork provide conical side tap connections.

3. Contractor Fabricated Round Duct – Medium Pressure: (Contractors Option)

a. Round, Longitudinal- and Spiral Lock-Seam Ducts: Field-fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards-Metal and Flexible." Fabricate ducts larger than seventy two (72) inches (1830 mm) in diameter with butt-welded longitudinal seams.

b. Duct Joints:

1) Ducts up to twenty (20) Inches (500 mm) in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.

c. Tees and Laterals: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards-Metal and Flexible," with metal thicknesses two gauge numbers heavier than specified for longitudinal-seam straight ducts.

d. Elbows: Use die-formed, gored, pleated, or mitered construction with bend radius of one and one half (1-1/2) times duct diameter. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards-Metal and Flexible," with metal thickness two gauge numbers heavier than specified for longitudinal- seam straight ducts.

4. Factory Fabricated Manual Volume Dampers:

a. Rectangular/Square_Manual Volume Dampers – Low Pressure Ductwork: Provide manual volume dampers in low pressure duct systems where the system pressure does not exceed 2” wg and the air velocity is less than 1,500 fpm where shown on drawings and/or where needed for system balancing. Dampers shall be single blade and/or opposed blade type dampers as specified below:

1) Single Blade Dampers Ductwork Less Than Twelve (12) Inches High:: Dampers shall be Ruskin Model MD25 single blade type

manual damper with a 24 gauge galvanized steel frame, a 22 gauge galvanized steel blade, molded synthetic bearings, three eights (3/8) inch square axle shaft extending beyond the frame, factory supplied hand quadrant with wing nut, and a two (2) inch standoff bracket. Quadrant handle shall be inscribed with "closed", "1/4 open", "1/2 open", "3/4 open" and "open".

a) Size Range in Inches (W x H): 5 x 4 to 12 x10 or

2) Opposed Blade Dampers Ductwork Twelve (12) Inches High and Higher: Dampers shall be Ruskin Model MD35 opposed blade type manual damper with a 24 gauge galvanized steel frame, a 22 gauge galvanized steel blade, molded synthetic bearings, three eights (3/8) inch square axle shaft extending beyond the frame, factory supplied hand quadrant with wing nut, and a two (2) inch standoff bracket. Quadrant handle shall be inscribed with "closed", "1/4 open", "1/2 open", "3/4 open" and "open". See example size range below and drawings for actual duct sizes and locations.

a) Example Size Range in Inches (W x H): 12 x 12 to 36 x12

b. Round Manual Volume Dampers – Low Pressure Ductwork: Provide manual volume dampers in low pressure duct systems where the system pressure does not exceed 2" wg and the air velocity is less than 1,500 fpm where shown on drawings and/or where needed for system balancing. Dampers shall be single blade type dampers as specified below:

1) Single Blade Dampers Ductwork Twelve (12) Inches in Diameter or Less: Dampers shall be Ruskin Model MDRS25 single blade type manual damper with a 20 gauge galvanized steel frame, a 20 gauge galvanized steel blade, molded synthetic bearings, three eights (3/8) inch square axle shaft extending beyond the frame, factory supplied hand quadrant with wing nut, and a two (2) inch standoff bracket. Quadrant handle shall be inscribed with "closed", "1/4 open", "1/2 open", "3/4 open" and "open". See example size range below and drawings for actual duct sizes and locations of runouts to diffusers.

a) Example Size Range in Inches (diameter): Four (4) inch to twelve (12) inch in diameter.

c. Flat Oval Manual Volume Dampers – Low Pressure Ductwork: Provide manual volume dampers in low pressure duct systems where the system pressure does not exceed 2" wg and the air velocity is less than 1,500 fpm

where shown on drawings and/or where needed for system balancing. Dampers shall be single blade type dampers as specified below:

1) Single Blade Dampers Ductwork Twelve (12) Inches in Diameter or Less: Dampers shall be Ruskin Model CDO25 single blade type manual damper with a 20 gauge galvanized steel frame, a 20 gauge galvanized steel blade, molded synthetic bearings, three eights (3/8) inch square axle shaft extending beyond the frame, factory supplied hand quadrant with wing nut, and a two (2) inch standoff bracket. Quadrant handle shall be inscribed with "closed", "1/4 open", "1/2 open", "3/4 open" and "open". See example size range below and drawings for actual duct sizes and locations of runouts to diffusers.

a) Example Size Range in Inches (diameter): Four (4) inch to twelve (12) inch in diameter.

5. Contractor Shop Fabricated Manual Volume Dampers: (Contractors Option)

a. Shop fabricated manual volume dampers must adhere to the same material and performance requirements specified for factory fabricated manual dampers.

6. Duct Access Doors:

a. Provide access doors in ductwork for ATC Dampers. For access door construction and air tightness, see SMACNA standard figure 2-12. Access doors shall be not less than 18" x 18" in size.

B. HVAC Material - Diffusers and Grilles:

1. Supply Air Grilles shall be Titus, Type 300RL with off-white baked enamel finish. See drawings for grille size.

2. Return and/or exhaust grilles shall be TITUS, Type 25RL steel grille with off-white baked enamel finish. See drawings for grille size.

2.11 INSULATION – PIPE AND DUCT SYSTEMS

A. General:

1. All pipe and duct systems shall be insulated with Owens Corning Insulation Products or approved equal by John Manville, Knauf Inc. or Pittsburgh Corning Corp. Foamglas.

2. Provide Tapes, Adhesives, Mastics and Sealants that are compatible with and approved by the insulation manufacturer.

3. HVAC Piping Systems include the following:

   a. Hydronic Piping Systems: Includes Process Cooling Water Systems.

4. HVAC Duct Systems include the following:

   a. Supply Duct Systems: Low Pressure Duct Systems.

B. Piping Systems:

1. HVAC Cold Piping Systems: 0ºF to 100ºF: (Process Cooling Water and A/C/ Condensate):

   a. Concealed and Exposed Interior Piping: Insulation for pipe sizes one half (1/2) inch to two (2) inches insulation shall comply with the following:
      1) Material: Fiberglass, Cellular Glass
      2) Thickness: One (1) inch
      3) Vapor Barrier: Yes
      4) Field Applied Jacket – Concealed: None
      5) Field Applied Jacket – MER Exposed: Glass Cloth
      6) Field Applied jacket – Non MER Exposed: PVC
      7) Pipe Fittings: “Zeston” pre molded fittings

C. Duct Systems:

1. HVAC Supply Duct Systems:

   a. Exposed Interior Supply and Return Duct Systems – MER: (Square, Rectangular, Round)
      1) Material: Fiberglass, Board (Square and Rectangular)
      2) Thickness: One and one half (1-1/2) inch
      3) Vapor Barrier: Yes
      4) Field Applied Jacket – Concealed: None
      5) Field Applied Jacket – MER Exposed: None
      6) Field Applied jacket – Non MER Exposed: None

2.12 AUTOMATIC TEMPERATURE CONTROLS

A. General: Unless otherwise directed by UMB all work associated with the Building Automation System (BAS), including required demolition work shall be furnished and installed by the BAS Contractor. The BAS Contractor for this project shall be Siemens Bldg. Tech. Inc.

B. Communication with third party products or products other than Siemens Apogee System: All products and/or devices that require software communication with the Siemens BAS shall be accomplished using BAC Net IP Communication Protocol.

C. Control Valves:

1. Control Valves: All control valves shall be electronic type valves designed for quiet operation and 100% tight shut off against the system operating pressure. Valves concealed above suspended ceilings or in unit casings shall be packless type with bellows seals requiring no packing maintenance.

2. All control valves (1/2" to 1") shall be globe type valves with bronze or forged brass body, NPT threaded ends, brass trim, type 303 stainless steel stem, metal to metal seat, ethylene propylene 'O' ring packing, ANSI Class 250, and selected to provide the scheduled gpm flow rate @ a maximum pressure drop of ten (10) feet. See equipment schedules for design flow rates.

3. Valve Fail Safe Position: Control valves fail safe position shall comply with the following:

a. Process Water Valves Non Vivarium Areas – Fail Last Position: Upon a loss of a signal or power control valves and actuators used as chilled water valves for fan coil/chilled beam terminal units shall fail in the last position.

D. ATC Valve Actuators: Valve actuators shall be mounted on the valve body and shall provide complete modulating control of the valve. The actuator motor shall de-energize when the valve has reached the operator or system determined position. Each actuator shall be removable without removing the valve from service or draining the system. Actuators shall be electronic.

E. Current Sensor: All motors serving HVAC fans and pumps shall be provided with a current sensor for "on/off" status to the BAS.

F. Fans: Verification of air flow for fans, which are part of cooling units shall be by a current sensing device unless indicated otherwise on the point schedule. All fans shall be provided with current sensors for "on/off" status to the BAS.

G. Temperature Sensors (DDC):

1. General: Provide temperature sensors for controllers performing space temperature control. Sensors shall be wired thermistor type, with the following features:

   a. Accuracy: + .5°F.
   b. Operating Range: 35°F to 115°F.
   c. Set Point Adjustment Range: 55°F to 95°F.
   d. Calibration Adjustments: None required.
   e. Installation: Up to one hundred (100) ft. from controller.
   f. Auxiliary Communications Port: As required.
   g. Set Point Adjustment Dial: As required.
   h. Occupancy Override Switch: As required.
   i. Terminal Jack: As required.
   j. Cover: Blank cover, no display.

2. Set Point Modes: Provide the following set point modes:

   a. Independent Heating, Cooling.
   b. Night Setback-Heating.
   c. Night Setback-Cooling.

3. 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.

4. 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 (2) line display, or via the portable operator's terminal.

5. 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 (2) line display or via the portable operator's terminal.

6. Room Sensors and Monitors: The following sensors for space control and/or space monitoring where indicated on the drawings and as required for proper control for the project:

    a. Room Mounted 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.

H. ATC Dampers: Dampers shall be airfoil type, low leak dampers with 16 gauge galvanized. steel channel frame reinforced with corner braces equal to 13 gauge galvanized steel blades shall be 14 gauge equivalent thickness galvanized steel roll formed airfoil type with extruded vinyl edge seals mechanically locked into blade edge & suitable for -50ºF to +250ºF operating temperature range. Jamb seals shall be flexible metal compression type. Bearings shall be corrosion resistant permanently lubricated stainless steel type turning in an extruded hole in the damper frame. Axles shall be positively locked into the damper blade. Linkages shall be concealed out of the airstream within the damper frame. Damper leakage rating shall be less than 6.2 CFM per sq. ft. thru a 48 inch x 48 inch damper at four (4) inches W.G. pressure difference. Damper shall be Ruskin model CD 60 or approved equal. All ATC Dampers shall be provided with end switches.

I. ATC Wiring & Conduit:

1. Wiring and conduit necessary for all control work shall be provided by the ATC Contractor. All electrical work shall be in accordance with the National Electric Code latest edition. All control cabling between the TEC and each room sensor shall be provided by the ATC Contractor. Electrical Contractor shall provide a one half (l/2) inch EMT between each TEC and room sensor.

2. All 110V power wiring for the control transformer shall be provided by the Division 26 Electrical Contractor from the circuit breaker to a junction box located near the control transformer. All 110V power wiring between the junction box and the control transformer shall be provided by the ATC Contractor.

J. Graphics and Programing – Existing Siemens System:

1. Graphics: For campus renovation projects, the BAS Contractor shall provide a graphics package as follows:

    a. Existing Graphics: Where graphics exist in the Siemens System for the project, the BAS contractor shall either modify the existing graphics or replace the existing graphics with new graphics indicating the architectural

changes to the project area and the locations of air terminal units or HVAC equipment and BAS sensors.

b. New Graphics: Where the Siemens System does not include graphics for the project, the BAS contractor shall provide a new graphics package for the project area indicating the architectural changes to the project area and the locations of air terminal units or HVAC equipment and BAS sensors.

c. New Graphics Background: Where new backgrounds are created by the BAS contractor these backgrounds must reside on and be compatible the Siemens Front End System and software. The BAS contractor can either create the background or utilize a CAD dwg file from the consultant or UMB as the background.

2. Programing: For campus renovation projects, the BAS Contractor shall provide the required programing as follows:

a. Existing Programing: Where programing exists in the Siemens System for the existing air terminal units or HVAC equipment that is either relocated, or removed and replaced, the existing building automation system programming shall be either modified or deleted, and a new program written by the BAS contractor to identify the air terminal units with the rooms they serve as part of the ATC work for the project.

b. New Programing: Where programing does not exist in the Siemens System for the existing air terminal units or HVAC equipment that is either relocated, or removed and replaced, the BAS contractor shall provide new programming to identify the air terminal units with the rooms they serve as part of the ATC work for the project. The new programing must reside on and be compatible the Siemens Front End System and software.

c. Miscellaneous: Programming modifications shall also include the occupied and unoccupied modes of control for each terminal unit or lead/lag operation for HVAC equipment.

K. Uninterruptible Power Supplies (UPS):

1. All Building Automation System field panels and application specific controllers shall be provided with Uninterruptible Power Supplies (UPS). Provide a single UPS, if possible, at each central field panel location, sized for total load of connected equipment. Provide external battery cabinets, if required to meet load requirements.

2. Provide constant on line 1500 kVA minimum UPS with Ethernet card to feed back to IP based UMB monitoring system Eaton Model PULSL1500T, Style #86703, 120V 1.5 kVA UPS with a MS Network Management Ethernet Card, Part # Network – MS, and a UPS bypass for seamless servicing. When a larger

UPS is required, increase the kVA capacity as needed. Line interactive UPS's will not be acceptable.

L. BAC Net IP Interface to the BAS:

1. Provide a patch panel and all required wiring as needed to connect the BAC Net IP based HVAC equipment to the BAS. Coordinate with UMB for the location of the panel in the building.

M. Sequence of Operation: (All DDC):

1. Water Cooled A/C Unit:

a. The Building Automation System (BAS) shall send enable/disable signal to the A/C Unit.

b. 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.

c. 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 Card and the unit shall be de-energized.

d. 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 Card and the unit shall be de-energized.

e. On units with 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.

f. Provide BAC NET IP Communication Software to interface with the water cooled A/C unit controls.

g. The following points are included with the A/C Unit microprocessor controller. BAS shall provide BAC NET IP communication software to allow for BAS monitoring. Listed points are based on manufactured equipment. Points one (1) through thirteen (13) and sixteen (16) and seventeen (17) shall be alarmed and trended by the BAS:

1) Unit on/off – Digital Output
2) Compressor running Module 1 – Digital Output
3) Fan running Module 1 – Digital Output

4) Compressor low pressure alarm Module 1 – Digital Input
5) Compressor high pressure alarm Module 1 – Digital Input
6) Air flow alarm Module 1 – Digital Input
7) Water detector alarm Module 1 (condensate pan) – Digital Input
8) Room temperature too high alarm – Digital Input
9) Room temperature too low alarm – Digital Input
10) Supply temperature too high alarm – Digital Input
11) Supply temperature too low alarm – Digital Input
12) Water temperature too high alarm – Digital Input
13) Water temperature too low alarm – Digital Input
14) Set point space temperature – Analog Input
15) Set point supply air temperature – Analog Input
16) Return air temperature – Analog Input
17) Supply air temperature – Analog Input
18) Discharge damper position – Digital Input
19) Return damper position – Digital Input

h. For systems requiring auxiliary drain pans the following point shall be alarmed through the BAS:

1) Auxiliary Drain Pan Water Detector Alarm – Digital Input

N. Description – Input/Output Point Summary: 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. Points labeled with * shall be trended.

1. ATC Isolation Dampers:

a. Analog Binary Input:
1) Status

b. Digital Output:
1) On – Off

c. System Features:
1) Alarm
2) Proof

2. ATC Valves:

a. Analog Binary Input:

1) Status

b. Digital Output:
1) On - Off

c. System Features:
1) Alarm
2) Proof

3. System Features (Typical for '1' through '14' above):

a. General:
1) Color Graphics
2) DDC Control
3) Programming
4) Trend

b. For points related to supplemental A/C equipment see points list specified elsewhere.

c. For points related to HVAC Systems coordinate with UMB and insert as directed.

2.13 TESTING AND BALANCING AND FILTER TESTING

A. Testing and Balancing (TAB):

1. General: All TAB work shall be accomplished by an air balancing agency certified by AABC only. NEBB certified balancing companies will not be permitted.
2. TAB Report: The TAB contractor shall submit one (1) electronic "pdf" file of the TAB report to engineer for review.

2. Scope of Work: Balance the HVAC systems on the drawings for air quantities and/or GPM flow rates indicated on the plans.

B. Filter Testing: Contractor shall make arrangements for a D.O.P. leak test for the filter assembly by an approved testing agency before exhaust system is placed in service by owner. Testing agency shall be 'Laminar Flow Consultants', Reston, VA.

2.14 OPERATION AND MAINTENANCE MANUAL – ELECTRONIC FILES

A. HVAC O & M Manual File: Provide one (1) electronic file "pdf format" for the Material and Equipment included in Division 23. The electronic file shall include one (1) copy of each approved submittal, approved TAB report, any manufacturer's maintenance manuals, and 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 Closeout Procedures.

2.15 DUCT AND PIPE LEAK TESTING

A. Duct System Leak Test:

1. General: The Contractor conducting the test shall use this Test Procedure for all new duct systems. All new pressurized duct systems (positive and negative) shall be leak tested prior to the duct insulation being installed and/or the duct systems being concealed in shafts and/or above hard ceilings where indicated on the drawings. Where duct systems are indicated to be concealed, these duct systems shall not be enclosed until each system as successfully passed its leak test. Test each duct system as a whole or in segments as required by progress of the work.

2. Duct Construction and Seal Class: All ductwork will be constructed to meet the requirements of SMACNA Seal Class A and shall be leak tested to meet the requirements of SMACNA Leak Class 2.

3. Leak Test Requirements: Unless otherwise directed by UMB, 100% of each non welded duct system shall be leak tested following the outlines and classifications in "The SMACNA HVAC Air Duct Leakage Test Manual" 2012 or latest edition or 1% duct leakage, whichever is greater. The total allowable leakage shall not exceed SMACNA Leak Class 2 for all duct construction. This UMB requirement exceeds standard SMACNA requirements.

4. Pre-Test Procedure:

   a. 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.

   b. 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 plates when the testing has been completed and approved by UMB.

5. Leak Test Procedure:

   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 from 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 joints 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 1, 2, 3 and 4 above. If the pressure test fails again the contractor shall repeat the entire process until the tested section passes the leak test.

B. Pipe System Hydronic/Leak Test: hydronically

1. HVAC Piping Systems: The following Pipe Systems shall be Hydronically Leak Tested by the contractor. All piping systems shall be proven tight in the presence of UMB Project Engineer prior to installation of insulation, and connection to exist piping systems. Provide all equipment and labor necessary for hydrostatically testing each system for one (1) hour at the minimum pressures as specified herein unless otherwise noted:

   a. Cooling water piping 100 psig
   b. Condensate piping 100 psig

C. Leak Test Forms:

1. Contractors shall use the UMB Standard Leak Test Summary Forms for recording the leak test results for all duct and pipe systems tested on this Project as follows:

a. Leak Test Duct Systems: See Part 3 for a sample of the UMB Standard Air Duct Leak Test Summary Form.

b. Hydronic/Leak Test Pipe Systems: See Part 3 for a sample of the UMB Standard Pipe System Hydronic/Leak Test Summary Form.

2.16 COMMISSIONING MECHANICAL SYSTEMS:

A. Test Equipment: Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to testing equipment.

PART 3 - EXECUTION:

3.1 GENERAL REQUIREMENTS – EXECUTION

A. All construction work that creates excessive noise will not be permitted during normal business hours. See Division 01 Specification Section "Cutting and Patching" for requirements.

3.2 CONNECTIONS AND ALTERATIONS TO EXISTING WORK

A. When existing mechanical work is removed, all pipes, valves, ducts, etc. shall be removed back to the active pipe and duct mains and capped.

B. Removal and/or relocation of existing services shall be closely coordinated with Facilities Management if they impact adjacent areas which shall remain operational.

C. While performing connections and alterations to existing mechanical work, the contractor shall take extreme care to protect all existing materials, equipment, casework etc. from dirt, debris, and damage. Any damage caused by the contractor to existing materials, equipment, casework, etc. shall be repaired to UMB's satisfaction and specifications at the contractor's expense.

3.3 CUTTING AND PATCHING

A. Cutting and patching associated with the work in the existing structure shall be performed a neat and workmanlike manner. Existing surfaces that are damaged by the contractor shall be repaired or provided with new materials to match existing.

B. Structural members shall not be cut or penetrated. Holes cut through concrete and/or masonry to accommodate new work shall be cut by reciprocating or rotary, non-percussive methods.

C. Patching of areas disturbed by installation of new work and/or required demolition shall match existing adjacent surfaces as to material, texture and color.

3.4 CUTTING, WELDING, BURNING

A. Before the contractor and/or any sub-contractor commences any cutting, welding, burning, brazing (pipe sweating), or any other type of work the contractor shall obtain a hot work permit from the UMB Fire Marshal at extension 1-410-706-3494 or 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 the UMB Fire Marshal.

3.5 INSTALLATION – HVAC PIPING SYSTEMS

A. Install all piping systems level and parallel to the building walls, and partitions. Diagonal runs are prohibited unless specifically indicated otherwise.

B. Where horizontal piping offsets to clear obstructions such as ductwork, structural members and work installed by other trades provide drain valves and air vents in locations where they can be accessed.

C. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

D. Install piping in concealed locations unless otherwise indicated.

E. Install piping exposed in equipment rooms and service areas unless otherwise noted.

F. Pipe Joints: Comply with the following:

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
4. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

3.6 PIPING SPECIALTIES

A. Dielectric Connections:

1. Install dielectric connections when piping of dissimilar metals piping and tubing are joined.

2. Dielectric Connections for NPS 2 and Smaller: Use stainless steel threaded nipples.

3. Dielectric Connections for NPS 2-1/2 and Larger: Use dielectric flange kits.

3.7 INSTALLATION – PIPE SLEEVES

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 in Part 1.

D. Fire-Barrier Penetrations: Comply with requirements for firestopping specified in Part 1.

3.8 INSTALLATION – VALVES

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 pipe systems.

C. Where piping or equipment may be subsequently removed, 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. Shut off valves serving equipment and/or control valves shall be installed full size at the equipment connection.

E. Where there is no interference, shut-off valves shall be installed with hand wheel located up on the horizontal runs of pipe to prevent accumulation of foreign matter in working parts of valves.

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. Where valves are installed in piping systems for pressure gauges, P/T plugs, DP Switches etc, for each device provide a three quarter (3/4) inch tap in piping systems one (1) inch and larger and provide a one half (1/2) inch tap in piping systems less than one inch.

H. Install drain valves at low points of risers and at trapped/low points in mains, branch lines, and everywhere else required to permit drainage of the entire piping system.

I. 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.

J. 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. In heating hot water systems where dielectric unions are required, provide unions rated for an operating temperature of at least 200ºF minimum.

3.9 INSTALLATION – INTERIOR HANGERS AND SUPPORTS

A. Piping Systems: Hangers and supports shall be provided for all piping systems, as recommended by the hanger manufacturers for the existing structural elements. Additional requirements are as follows:

1. On piping systems requiring insulation, hangers and supports shall be installed external to the insulation material, and sheet metal saddles shall be provided.

2. Hangers and supports shall be provided at all changes of direction and elevations on piping system.

3. Spacing shall be as recommended by manufacturer, for each pipe size and material type.

B. Duct Systems: Hangers and supports shall be provided for all duct systems, as recommended by SMACNA for the existing structural elements. Additional requirements are as follows:

1. Spacing shall be as recommended by SMACNA, for each duct size and material type.

2. Support horizontal ducts within two (2) feet of each elbow and within four (4) feet of each branch intersection.

3.10 INSTALLATION – DUCT WORK

A. Install all rigid ducts with support systems indicated in SMACNA "HVAC Duct Construction Standards," Tables 4-1 through 4-3 and Figures 4-1 through 4-9.

B. Install all ducts with the fewest possible joints.

C. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.

D. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

E. Install louvers and accessories complete with mounting frames as indicated on the drawings. Coordinate all rough opening requirements with all trades prior to fabrication or procurement of any penetrations.

F. Horizontal Ducts: In finished spaces with suspended ceilings conceal the horizontal ducts above suspended ceilings. In finished spaces without suspended ceilings install as shown on drawings and details.

G. Vertical Ducts: Conceal vertical ducts in hollow wall construction in finished spaces or in utility shafts as indicated on the drawings and details.

H. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and are exposed to view, conceal space between construction opening and duct and/or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on four (4) sides by at least one and one-half (1-1/2) inches.

I. Fan Powered Equipment Connections: Connect ducts to fan powered equipment with flexible connections. Comply with SMACNA "HVAC Duct Construction Standards," for requirements.

J. Branch Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figures 2-5, 2-6, 2-14 and 2-15.

K. Seam and Joint Sealing: Seal duct seams and joints as follows:

1. Seal all transverse joints, longitudinal seams, and duct penetrations.

2. Seal externally insulated ducts prior to insulation installation.

3.11 INSTALLATION – PIPE AND DUCT INSULATION

A. Fiberglass Pipe Insulation:

1. All insulation shall be installed by a qualified insulation contractor. Insulation installed on cold surfaces shall have a vapor barrier and exposed ends shall be sealed. All insulation shall be installed and all seams, sealed, with Benjamin Foster sealant, according to manufacturer's recommendations.

2. Bond insulation to pipe with lagging adhesive.

3. Seal exposed ends with lagging adhesive.

4. Seal seams and joints with vapor barrier compound.

5. Where existing pipe insulation is disturbed for demolition work, and piping is capped, repair and seal damaged insulation.

6. Where existing pipe insulation is disturbed for demolition work, and new piping is connected at that location, butt new insulation up to the existing insulation and seal the joints as specified herein.

7. On new piping systems requiring insulation all pipe insulation shall be continuous through point of support. Provide sheet metal saddles between insulation and pipe hangers.

8. Where new piping connects to existing piping the new insulation shall match the thickness of the existing insulation.

B. Fiberglass Duct Insulation:

1. Install insulation tight and smooth to the duct surface.

2. Secure to ducts having long sides or diameters as follows:

a. Smaller than twenty four (24) inches: Apply bonding adhesive in six (6) inch wide transverse strips on twelve (12) inch centers.

b. Twenty four (24) inch and larger: install anchor pins spaced twelve (12) inches apart each way. Apply bonding adhesive to prevent the insulation from sagging.

c. Overlap the joints three (3) inches.

d. Seal joints, breaks, tears, and punctures with vapor barrier compound.

e. Where existing duct insulation is disturbed for demolition work, and duct is capped, repair and seal damaged insulation.

f. Where existing duct insulation is disturbed for demolition work, and new ductwork is connected at that location, butt new insulation up to the existing insulation and seal the joints as specified herein.

3.12 INSTALLATION – PIPE LABELS

A. General: Provide pipe labels with directional arrows every twenty five (25) feet on straight runs of horizontal and vertical pipes exposed in equipment rooms, utility shafts and above ceilings. In addition to the referenced spacing above comply with the following:

1. Where pipes pass through floors, walls and partitions provide pipe labels on each side of the penetration.

B. Exposed Piping: Install pipe labels in accessible locations on the piping systems so they are visible from the floor. Do not install pipe labels on sections of pipe that are not in a person's sight line.

C. Concealed Piping: Install pipe labels in accessible locations on the piping systems so they are visible from the point of access through the ceiling tile or ceiling access door.

D. Directional Arrows: Install directional arrows to indicate the correct flow direction.

E. All pipe labels and flow arrows that are found to be incorrectly installed shall be replaced and corrected at no additional cost to the project.

3.13 INSTALLATION – DUCT LABELS

A. General: Provide duct labels every twenty five (25) feet on straight runs of horizontal and vertical exposed ducts in equipment rooms, utility shafts and above ceilings. In addition to the referenced spacing above comply with the following:

1. Where ducts pass through floors, walls and partitions provide duct labels on each side of the penetration.

B. Exposed Ducts: Install duct labels in accessible locations on the duct systems so they are visible from the floor. Do not install duct labels on sections of duct that are not in a person's sight line.

C. Concealed Ducts: Install duct labels in accessible locations on the duct systems so they are visible from the point of access through the ceiling tile or ceiling access door.

D. Directional Arrows: Install directional arrows to indicate the correct flow direction.

E. All duct labels and flow arrows that are found to be incorrectly installed shall be replaced and corrected at no additional cost to the project.

3.14 CLEANING AND FLUSHING

A. General Requirement: The contractor shall secure the services of the water treatment company that is under service contract to UMB, to clean, flush and add chemical treatment to new piping systems that are required to be connected to existing piping systems serving the building or campus. The cost for labor and material for this work must be included in the contractors bid price. The contractor shall be responsible for the scope of work for the UMB water treatment company.

B. 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.

C. Before adding chemicals to the system, isolate coils for heating and cooling equipment, and open bypasses.

D. 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 one and one half (1-1/2) 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.

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 to the UMB Project Manager.

3.15 COMMISSIONING NEW MECHANICAL SYSTEMS

A. Testing Preparation:

1. Certify in writing to the CxA that new mechanical systems, subsystems, and equipment have been installed, calibrated and are operating according to the Contract Documents.

2. Certify in writing to the CxA that new HVAC hydronic piping systems have been flushed and disinfected according to the Contract Documents.

3. Certify in writing to the CxA that new 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.

4. 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.

5. Place new systems, subsystems, and equipment into operating mode to be tested (e.g., for supply and exhaust terminal units, and/or exhaust fans normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

6. Inspect and verify the position of each device and interlock identified on checklists.

7. Check safety cutouts, alarms, and interlocks for supplemental A/C equipment with the BAS.

8. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

B. Tab Verification:

1. 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.

2. Provide technicians, instrumentation, and tools to verify testing and balancing of new HVAC systems at the direction of the CxA.

    a. 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.
    b. The TAB subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
    c. Failure of an item includes, other than sound, a deviation of more than +/- 10%.
    d. Failure of more than 10% of selected items shall result in rejection of final TAB report.
    e. TAB contractor shall remedy the deficiency and notify the CxA so verification of failed portions can be performed.

C. General Testing Requirements:

1. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

2. Scope of HVAC testing shall include new HVAC installation, from the existing building systems through the new distribution systems to the renovated spaces. Testing shall include measuring capacities and effectiveness of operational and control functions.

3. 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.

4. The CxA along with the HVAC contractor, TAB Subcontractor, and HVAC Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for new HVAC systems, subsystems, and equipment.

5. Tests will be performed using design conditions whenever possible.

6. 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.

D. New HVAC Systems, Subsystems, and Equipment Testing Procedures:

1. Procedures: Where applicable follow manufacturer's written procedures. If no procedures are prescribed by the manufacturer, proceed as follows:

   a. HVAC Piping Distribution Systems: Includes new chilled water, hot water heating, natural gas, steam and condensate piping systems.
   b. Verify that all new valves and accessories have been installed correctly, are accessible and operate as intended.
   c. Verify that specified leak tests of piping systems are complete.

2. New HVAC Air Distribution Systems: Includes new supply, general exhaust, fume hood and miscellaneous exhaust duct systems.

   a. Verify that all new 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. New HVAC Equipment: Includes new terminal units, new supplemental A/C units and exhaust fans.

   a. Verify that all new equipment has been installed in accordance with the manufactures recommendations and all equipment can be easily accessed for maintenance.
   b. Verify that all new valves, trim, fittings, controls, and accessories have been installed correctly and operates as intended.
   c. Verify that all new required interfaces with the BAS have been installed correctly and operates as intended.
   d. Operate new equipment as intended to ensure the design conditions can be obtained.

4. New HVAC Building Automation System Interface:

   a. Verify that all new control hardware and software, sequences of operations, and integration of factory controls has been installed correctly and operates as intended.
   b. Verify that all new control valves, trim, fittings, and accessories have been installed correctly and operates as intended.
   c. Verify that all new equipment test, training, and startup procedures have been completed per the specifications.
   d. Verify that all new required interfaces between the BAS and HVAC equipment have been installed correctly and operates as intended.
   e. Verify that all new control graphics and programming has been installed in accordance with the manufactures recommendations and operates as intended.
   f. Operate new equipment as intended to ensure the design conditions can be obtained.
   g. Where existing terminal equipment and/or exhaust fans are reused and/or relocated verify related control components are installed as indicated.

3.16 CLEAN – UP

A. Excessive debris and dirt, such as occurs from cutting through masonry or plaster walls shall be cleaned up from the equipment and removed immediately after the work of cutting through the walls.

B. Debris shall be removed from UMB property.

C. Ceiling panels shall be replaced as soon as work is finished in the area, and shall be kept free of dirty finger prints. Where work is being done in corridors used by patients and ceiling panels shall be replaced at the close of the day's work even if work is at the particular location is incomplete.

D. All areas shall be left broom-clean at the end of the work period.

E. Remove all mechanical clipping, wiring, nuts, bolts, etc. left on top of ceilings and ceiling tiles.

3.17 WET TAP PROCESS

A. General: When existing HVAC hydronic systems cannot be shut off and drained for new connections the contractor shall make arrangements with UMB to wet tap the system requiring new connections as follows:

1. Piping Systems up to Four (4) Inches: Use an Apollo 77FLF-140 full port ball valve only as specified. Size the valve to match the new pipe connection.

2. Piping Systems Six (6) Inches and Larger: Provide an appropriately sized gate valve for the wet tap process. Provide a specified butterfly valve downstream of the gate valve for shut off duty. Size the butterfly valve to match the new pipe connection. Lock the gate valve in the open position.

3.18 COMPLETED HYDROSTATIC/ LEAK TEST FORMS

A. Upon completion of each hydrostatic/test, the contractor shall up load the signed leak test forms to the Project File, in ebuilder, in Folder 11.06 Test Reports.

3.19 UMB STANDARD TEST SUMMARY FORMS

A. General: Contractors shall use the UMB Standard Forms for Recording the Hydrostatic/Leak Test Results for all Duct and Pipe Systems Tested on this Project.

1. Pipe System Sample Form: See the following page for a sample of the UMB Standard Pipe System Hydrostatic/Leak Test Summary Form.

2. Availability: The standard test summary form is available on the UMB Web Site at http://www.umaryland.edu/designandconstruction/, under the “Documents” link.

3. Field Testing: For field testing download and copy the forms from the UMB web site. Do not use attached “Sample Forms” for testing

UMB STANDARD AIR DUCT SYSTEM LEAK TEST SUMMARY FORM

Project Name: _____ Project Number: _____ Page ___ of ___

Air System: _____ Specified Test Pressure: _____

Total System CFM: _____ Duct Construction Pressure Class: _____

Date of Test: _____

DESIGN DATA					FIELD TEST DATA RECORD				
		Leakage Criteria							
Subject Duct	Surface Area ($ft.^2$)	Leakage Class	Leakage Factor (CFM/100ft.)	Test Section CFM	Measured CFM	Test Data ΔP (inches wg)	Test Result Pass/Fail	Test Performed By	Test Witnessed By

UMB STANDARD PIPE SYSTEM HYDROSTATIC/LEAK TEST SUMMARY FORM

TEST DATA:

Date: _____ Project Number: _____

Location: _____

Pipe System Tested (Service): _____

Location and Description: _____

Pipe Materials: _____

Operating Pressure: _____

Specified Test Pressure: _____

Actual Test Pressure: _____

Pressure Test Type: _____

Test Start Time: _____ Recorded Test Pressure: _____

Test Completion Time: _____ Recorded Test Pressure: _____

Test Duration: _____ Pressure Drop or Rise: _____

Test Result (Pass/Fail): _____

SIGNATURES:

Construction Manager: _____

Construction Manager Representative: _____

Mechanical Contractor: _____

Mechanical Contractor Forman: _____

UMB Division: _____

UMB Witness: _____

Remarks: _____

END OF SECTION 230000

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 SITE VISIT

A. Prior to preparing the bid, the electrical 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.

1.5 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.

1.6 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).

1.7 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.

1.8 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.

1.9 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:
   a. Compression Wire Connectors
   b. Fire Resistant Sealant
   c. Ground Wire
   d. Raceway, Boxes and Cabinets
   e. Wires and Cables
   f. Fire Alarm System: Refer to Division 28 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 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. Calculations for battery capacity and voltage drop.

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.

1.10 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”

1.11 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 electrical part for the coordination drawing effort. Work with the other trades to ensure the material and equipment installed as part of 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 the penthouse 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.

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.

1.12 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.

1.13 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, 27 and 28 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”.

B. Alternate O & M File: The CM/General Contractor has the option to include all disciplines in a single O&M Manual file for smaller type renovation projects. The electronic O & M manual shall include one copy of each approved submittal, approved TAB report, any manufacturers maintenance manuals, all warranty certificates, arranged in file folders under each discipline for each submittal. Files shall be stacked and include both a book mark and tree structure for accessing each submittal file The electronic file structure for the single file shall be as follows:

1. Cover Sheet
2. Forward
3. General Information
4. Subcontractors List
5. Suppliers List
6. General Warranty Statement – include the manufacturer’s warranty with the equipment submittal in the appropriate discipline.
7. Architectural: group all architectural data under this heading with a tree structure.
8. Mechanical: group all mechanical data under this heading with a tree structure.
9. Electrical: group all electrical data under this heading with a tree structure.
10. Fire Protection: group all fire protection data under this heading with a tree structure.
11. As Built Drawings: Contractors Markups.

A. Provide service and operating manuals for the following:

1. Division 28 Section “Digital, Addressable Fire Alarm System”.

1.14 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.

1.15 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.

1.16 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.

1.17 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 (Not Applicable)

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.

B. As part of instruction for operating equipment, demonstrate the following procedures:
1. Start up.
2. Shut down.
3. Emergency operations.
4. Safety procedures.
5. Economy and efficiency adjustments.

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 a third (3^{rd}) Party Inspector approved by the Maryland

State Fire Marshal and paid for by the Contractor.

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. Patch, repair and repaint all walls and surfaces cut, penetrated or otherwise disturbed by the work.
   2. Patch holes and penetrations in wood, masonry and plaster.

3.13 FINAL CLEANING

A. General: General cleaning during construction is required by the General Conditions and included in 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 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 15,000volt electrical distribution system(s).

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. 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:

D. Material Certificates: For each cable and accessory type, signed by manufacturers.

E. Source quality-control test reports. Certified reports of manufacturer’s design and production tests indicating compliance of cable and accessories with reference standards.

F. 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.

G. 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.

H. 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.

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.
f. Approved Equal.

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 Products.
b. Scotch.

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. Jacket: 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. Provide Modular Splice kits.

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.

2.5 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.

2.6 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.

2.7 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. In pull boxes and junction boxes, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.

D. Install cable splices at pull points and elsewhere as indicated; use standard kits.

E. Install terminations at ends of conductors with standard kits.

F. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit 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.

G. 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.

H. Identify cables according to Division 26 Section "Identification for Electrical Systems."

I. 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.

J. 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. 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.

    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 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.

1.6 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. American Insulated Wire Corp.; a Leviton Company.
2. General Cable Corporation.
3. Senator Wire & Cable Company.
4. Southwire Company.
5. The Okonite Company.
6. Belden, Inc.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.

D. 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. Coordinate sleeve selection and application with selection and application of 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 and 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. Exposed and Concealed Feeders: Type THHN-THWN, single conductors in raceway.

B. Exposed and Concealed Branch Circuits: Type THHN-THWN, single conductors in raceway.

C. Control Circuits: Type THHN-THWN, 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."

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

B. 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.

C. Cut sleeves to length for mounting flush with both wall surfaces.

D. Extend sleeves installed in floors three (3) inches above finished floor level.

E. 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.

F. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

G. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials.

H. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

I. 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.

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.7 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 for compliance with requirements.

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.

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

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:

1.3 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. Grounding arrangements and connections for separately derived systems.

C. Qualification Data: For qualified testing agency and testing agency's field supervisor.

D. Field quality-control reports.

E. Operation and Maintenance Data: For grounding 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. Instructions for periodic testing and inspection of grounding features at 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. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
4. 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.

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.

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 copper conductor, No. 2/0 AWG minimum.

C. Grounding Bus: Install in electrical substation room:

1. Install bus on insulated spacers two (2) inches minimum from wall, six (6) inches above finished floor unless otherwise indicated.
2. 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.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Connections to Structural Steel: Welded connectors.

3.2 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.

3.3 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. 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.

C. 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.

D. 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.

3.4 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."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing agency 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.

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. UPS output equipment: 1 ohm(s).
5. Substations and Pad-Mounted Equipment: 5 ohms.
6. 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

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. 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.

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 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. EMT: Electrical metallic tubing.

C. FMC: Flexible metal conduit.

D. LFMC: Liquidtight flexible metal 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. 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.

G. Joint Compound for Rigid Steel Conduit: 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.

2.3 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. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

D. 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.

E. 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.

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: RMC.
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R or 4.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Conduits > 2”: Rigid Steel.
4. All wiring > than 600 volts: Rigid Steel.
5. 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.

6. Concealed in Ceilings and Interior Walls and Partitions: EMT.
7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
8. Damp or Wet Locations: Rigid steel conduit.
9. Raceways for Concealed General Purpose Distribution of Communications Cable: EMT.
10. 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: 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. Raceway Terminations at Locations Subject to Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

I. 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.

J. 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.

K. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

3.3 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.4 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.

END OF SECTION 260533

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. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.

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 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.

2.4 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.

2.5 FLOOR MARKING TAPE

A. Two (2) inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 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. 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."

2.7 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.

2.8 EQUIPMENT IDENTIFICATION LABELS

A. Stenciled Legend: In non-fading, waterproof, black ink or paint. Minimum letter height shall be one (1) inch.

2.9 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.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one (1) piece, self locking, Type 6/6 nylon.

1. Minimum Width: Three sixteenth (3/16) inch.
2. Tensile Strength at 73°F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: -40°F to +185°F.
4. Color: “BLACK”.

2.10 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. 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. Mechanical and Electrical Supervisory Systems – “GREEN” and “BLUE”
6. 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. 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.

K. 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.

L. 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.

M. 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.

N. 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.
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. Switchgear – stencil and paint
d. Switchboards – stencil and paint
e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary – stencil and paint.
f. Substations – stencil and paint.
g. Emergency system boxes and enclosures – stencil and paint.
h. Push-button stations – laminated acrylic or melamine label.
i. Power transfer equipment – laminated acrylic or melamine label.
j. Contactors – laminated acrylic or melamine label.

k. Remote-controlled switches, dimmer modules, and control devices – laminated acrylic or melamine label.
l. UPS equipment – laminated acrylic or melamine label.
m. Each receptacle and light switches 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

SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

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 computer-based, fault-current, overcurrent protective device coordination studies, and arc flash analysis. Protective devices shall be set based on results of the protective device coordination study.

1.3 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and Equipment Evaluation Reports.
3. Coordination-Study Report.
4. Setting Report.
5. Motor starting Study.
6. Arc Flash Analysis.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For coordination-study specialist.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

1.5 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

1.6 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide or a comparable product by one (1) of the following:

1. CGI CYME.
2. EDSA Micro Corporation.
3. ESA Inc.
4. Operation Technology, Inc.
5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:

a. Arcing faults.
b. Simultaneous faults.
c. Explicit negative sequence.
d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:

a. Circuit-breaker and fuse-current ratings and types.
b. Relays and associated power and current transformer ratings and ratios.
c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
d. Generator kilovolt amperes, size, voltage, and source impedance.

e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
f. Busway ampacity and impedance.
g. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

a. Special load considerations, including starting inrush currents and frequent starting and stopping.
b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
d. Generator thermal-damage curve.
e. Ratings, types, and settings of utility company's overcurrent protective devices.
f. Special overcurrent protective device settings or types stipulated by utility company.
g. Time-current-characteristic curves of devices indicated to be coordinated.
h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

A. The study shall originate at the two incoming feeder breakers in the basement of Howard Hall, provided as part of the Infrastructure Upgrade Project, that serve the new substations provided in this project and replacing existing substations #4-7. The study shall include all overcurrent protective devices served by the new substations. Feeder settings must be coordinated with other buildings on the feeder.

B. The time-current coordination analysis shall be performed with the aid of a digital computer and will include the determination of settings, ratings, or types for the overcurrent protective devices supplied.

C. Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection and service continuity considered to be of equal importance.

D. A sufficient number of computer generated log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.

E. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, the short circuit current availability at the device location when known, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.

F. The study shall include a separate, tabular computer printout containing the suggested device settings of all adjustable overcurrent protective devices, the equipment where the device is located, the device number corresponding to the device on the system one-line diagram, and the number of the time-current log-log graphs where they are illustrated.

G. A computer generated system one-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known. Calculated short circuit currents are available from Owner.

H. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for increasing system protection or device coordination. Submit curves and study as a shop drawing for approval.

I. Factory set all relays, breaker trips, and select proper HV fuses which coordinate with transformer in rush current and circuit breakers.

J. Include in study the emergency generator main breaker and associated distribution system.

K. Preliminary coordination study shall be made by vendor prior to submission of shop drawings.

L. Sizes of fuses, breaker interrupting rating, and bus bracing shall be minimum, as shown on drawing. Exact sizing shall be according to coordination study.

M. Any changes to engineering documents, as a result of coordination study, shall not result in any additional cost to the Owner.

N. The Vendor shall contact the Engineer immediately if any delay occurs due to the lack of required information he needs to complete this study.

O. If any delay occurs due to time required for manufacturing of the indoor switchgear submit shop drawings on this switchgear prior to coordination study shop drawings.

P. Present organized time-current analysis of each protective device in series from main circuit breaker in branch circuit panelboard back to Utility Company devices protective service, including on-site service, main and federal circuit protective devices.

Q. Provide two (2) bound copies of the completed protective device time-current coordination analysis to the Owner.

R. All tests shall comply with IEEE standards.

3.4 COORDINATION STUDY

A. Calculation of the maximum rms symmetrical three-phase short-circuit current at each significant location in the electrical system shall be made using a professional computer software program.

B. Appropriate motor short-circuit contribution shall be included at the appropriate locations in the system so that the computer calculated values represent the highest short-circuit current the equipment will be subjected to under fault conditions.

C. A tabular computer printout shall be included which lists the calculated short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment.

D. The study shall include a computer printout of input circuit data including conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.

E. Include a bus-to-bus computer printout identifying the maximum available short-circuit current in rms symmetrical amperes and the X/R ratio of the fault current for each bus-to-bus calculation.

F. The system one-line diagram shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis.

G. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.

H. The contractor shall be responsible for supplying conductor information (lengths, types, number per phase, etc.) in a timely manner to allow the short-circuit analysis to be completed prior to final installation.

I. Any inadequacies shall be called to the attention of the UMB and recommendations made for improvements as soon as any they are identified.

J. Provide bound copies of the completed short-circuit analysis to UMB.

3.5 SWITCHING TRANSIENT ANALYSIS STUDY

A. A Switching Transient Analysis Study shall be made to determine the transient overvoltages for various switching conditions and their effect on the operation of the electrical system.

B. Various system conditions (consistent with previously gathered data from the Harmonic Analysis Study) shall be evaluated so that the proper overvoltage protection specifications may be developed.

C. Transient simulations shall be performed using a digital computer in order to determine transient voltage levels at the low voltage buses within the electrical system.

D. The electrical system parameters shall be varied to in order to determine their effect on the transient voltages.

E. Various solutions to excessive transient voltage levels shall be considered and additional computer simulations made to determine their validity.

F. The evaluation must consider solutions to power factor and harmonic concerns with respect to transient overvoltage levels.

G. Nuisance tripping of electronic power equipment (e.g. adjustable speed drives) shall be evaluated and corrective or preventive techniques suggested.

H. Provide two (2) bound copies of the completed Transient Analysis Study to the UMB.

3.6 LOAD FLOW AND VOLTAGE DROP ANALYSIS

A. The Load Flow and Voltage Drop Analysis shall be made using a digital computer and include calculations of power flow in all three-phase branch and feeder circuits, calculated voltages at each bus and voltage drops of each feeder.

B. The analysis shall provide the calculated maximum values of kVA, kW, kVAR, power factor, and amperes for each power circuit.

C. The calculated power losses in each branch and total system losses shall be provided.

D. A computer printout listing all cables, transformers, loads, and other circuit data shall be included.

E. Provide tabular bus-to-bus computer printouts listing the calculated values.

F. The analysis shall include a computer generated system one-line diagram clearly identifying individual equipment buses, bus numbers, cable and bus connections, power flow throughout the system, and other information related to the analysis.

G. A discussion section evaluating the loading and voltage levels for the system shall be provided and recommendations included as appropriate to improve system operation.

H. Significant deficiencies in loading or voltage levels shall be called to attention of UMB and recommendations made for improvements as soon as they are identified.

I. Provide bound copies of the completed Load Flow and Voltage Drop Analysis to UMB.

3.7 HARMONIC ANALYSIS STUDY

A. A Harmonic Analysis Study shall be made to determine the levels of harmonic voltages and currents in the system.

B. The type and level of compensation needed to achieve the desired power factor and acceptable levels of harmonics shall be considered.

C. Transient concerns shall be evaluated in order to determine the optimum equipment size, location in the system, and configuration.

D. The study shall make appropriate recommendations in order to provide proper protection and operation of the electrical system.

E. Harmonic source models will be developed for each nonlinear load (drive, etc.) type. The load characteristics shall be approximated based on the loads indicated on the project drawings.

F. The application of harmonic filters will be evaluated to determine the optimum filter size and configurations.

G. Computer simulations shall be performed to determine the system harmonic voltage and current levels and voltage distortion levels (and compared with measured values to determine the effect of various system conditions).

H. If required, harmonic filter specifications shall be developed with consideration to cost, filtering options, and effectiveness of harmonic filters.

I. Provide bound copies of the completed Harmonic Analysis Study to UMB.

3.8 ARC Flash Hazard Study

A. Perform an arc flash hazard study after the short circuit and protective device coordination study has been completed based upon IEEE Std. 1584, "IEEE Guide For Performing Arc Flash Hazard Calculations."

B. Pertinent data, rationale employed, and assumptions in developing the calculations shall be incorporated in the introductory remarks of the study.

C. The study shall be in accordance with applicable NFPA 70E, OSHA 29-CFR, Part 1910 Sub Part S and IEEE 1584 Standards.

D. Determine the following:

1. Flash Hazard Protection Boundary
2. Limited Approach Boundary
3. Restricted Boundary
4. Prohibited Boundary
5. Incident Energy Level
6. Required Personal Protective Equipment Class
7. Type of Fire-Rated Clothing

E. Produce an Arc Flash Warning label listing items 1-7 above. Also include the bus name, system operating voltage, and date of issue. Labels shall be printed in color and be printed on adhesive-backed Avery labels.

F. Produce Bus Detail sheets that lists the items D 1-7 from above and the following additional items:

1. Bus Name
2. Upstream Protective Device Name, Type, and Settings
3. Bus Line to Line Voltage

G. Produce Arc Flash Evaluation Summary Sheet listing the following additional items:

1. Bus Name
2. Upstream Protective Device Name, Type, and Settings
3. Bus Line to Line Voltage
4. Bus Bolted Fault
5. Protective Device Bolted Fault Current
6. Arcing Fault Current
7. Protective Device Trip/Delay Time
8. Breaker Opening Time

9. Solidly Grounded Column
10. Equipment Type
11. Gap
12. Arc Flash Boundary
13. Working Distance
14. Incident Energy
15. Required Protective Fire-Rated Clothing Type and Class

END OF SECTION 260573

SECTION 260913 - ELECTRICAL POWER MONITORING AND 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 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 data transmission protocols.
2. Power monitoring equipment (Power Monitors).
3. Programming and Software.

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.
5. UPS sizing calculations for workstation.
6. Surge suppressors: Data for each device used and where applied.

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: Upon substantial completion, provide 2 years of Schneider Electric Prime Level Digital Service Plan for on-line Technical Support

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.

C. Startup & Commissioning Service: Contract Schneider Electric for startup, commissioning and integration of meters provided into existing StruxureWare Power Monitoring System.

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 the following:
   1. Schneider Electric - Power Management Operation.

2.2 FUNCTIONAL DESCRIPTION

A. Instrumentation and Recording Devices: Monitor and record load profiles and chart energy consumption patterns.

   1. Calculate and Record the Following:

      a. Load factor.
      b. Peak demand periods.

   2. Measure and Record Metering Data for the Following:

      a. Electricity.

B. Software: Calculate allocation of utility costs.

   1. Automatically Import Energy Usage Records to Allocate Energy Costs for the Following:

      a. At least fifteen (15) departments.
      b. At least thirty (30) tenants.
      c. At least five (5) buildings.

C. Power Quality Monitoring: Identify power system anomalies and measure, display, and record trends and alarms of the following power quality parameters:

1. Voltage regulation and unbalance.
2. Continuous three-phase rms voltage.
3. Periodic max./min./avg. voltage samples.
4. Harmonics.
5. Voltage excursions.

D. Emergency Load Shedding. Preserve critical loads or avoid total shutdown due to unforeseen loss of power sources according to the following logic:

1. Determine system topology.
2. Evaluate remaining loads and sources.
3. Shed loads in less than 100 ms.

E. Demand Management:

1. Peaking or co-generator control.
2. Load interlocking.
3. Load shedding.
4. Load trimming.

F. System: Report equipment status and power system control.

2.3 POWER MONITORING EQUIPMENT

A. POWER METERS-Advanced PM5563RD

1. General Provisions

a. All setup parameters required by the Power Meter shall be stored in nonvolatile memory and retained in the event of a control power interruption.
b. The Power Meter may be applied in three-phase, three- or four-wire systems.
c. The Power Meter shall be capable of being applied without modification at nominal frequencies of 50, 60, or 400 Hz.

2. Measured values

a. The Power Meter shall provide the following, true RMS metered quantities:

1) Real-Time Readings

a) Current (Per-Phase, N (calculated), 3-Phase Avg, %Unbalanced)

b) Voltage (L–L Per-Phase, L-L 3-Phase Avg, L–N Per-Phase, 3-Phase Avg, % 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) THD (Current and Voltage)

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 Calculations(Per-Phase, 3-Phase Avg, Neutral):

(1) Present

(2) Running Average

(3) Last completed interval

(4) Peak

b) Demand Real Power Calculations(3-Phase Total):

(1) Present

(2) Running Average

(3) Last completed interval

(4) Predicted

(5) Peak

(6) Coincident with peak kVA Demand

(7) Coincident with kVAR Demand

c) Demand Reactive Power Calculations(3-Phase Total):

(1) Present

(2) Running Average

(3) Last completed interval

(4) Predicted

(5) Peak

(6) Coincident with peak kVA Demand

(7) Coincident kW Demand

d) Demand Apparent Power Calculations(3-Phase Total):

(1) Present

(2) Running Average

(3) Last completed interval

(4) Predicted

(5) Peak

(6) Coincident with peak kVA Demand

(7) Coincident kW Demand

e) Average Power Factor Calculations, Demand Coincident(True),(3-Phase Total):

(1) Last completed interval

(2) Coincident with kW peak

(3) Coincident with kVAR peak

(4) Coincident with kVA peak

f) Power Analysis Values

(1) THD – Voltage, Current (3-Phase, Per-Phase, Neutral)

(2) THD - Voltage, Current (3-Phase, Per-Phase, Neutral)

(3) Displacement Power Factor (Per-Phase, 3-Phase)

(4) Fundamental Voltage, Magnitude and Angle (Per-Phase)

(5) Fundamental Currents, Magnitude and Angle (Per-Phase)

(6) Fundamental Real Power (Per-Phase, 3-Phase)

(7) Fundamental Reactive Power (Per-Phase)

(8) Harmonic Power (Per-Phase, 3-Phase)

(9) Phase Rotation

(10) Unbalance (Current and Voltage)

(11) Harmonic Magnitudes & Angles for Current and Voltages (Per Phase) up to the 63rd Harmonic (31st on the PM810 plus PM810LOG and PM820).

3. Demand

a. All power demand calculations shall use any one (1) of the following calculation methods, selectable by the user:

1) Thermal demand using a sliding window updated every second for the present demand and at the end of the interval for the last interval. The window length shall be set by the user from 1-60 minutes in one minute increments.

2) Block interval, with optional sub-intervals. The window length shall be set by the user from one (1) minute 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 sixty (60) minutes in one (1) minute intervals. The following Block methods are available:

a) Sliding Block that calculates demand every second with intervals less than fifteen (15) minutes and every fifteen (15) seconds with an interval between fifteen (15) minutes and sixty (60) minutes.

b) Fixed Block that calculates demand at the end of the interval
c) Rolling Block that a subinterval is configured. Demand is calculated at the end of each subinterval and displays at the end of the interval.

3) Demand can be calculated using a Synchronization signal:

a) Demand can be synchronized to an input pulse from an external source. The demand period begins with every pulse. A synchronized input can be configured to either a block or rolling block calculation
b) Demand can be synchronized to a communication signal. This can be configured to either a block or rolling block calculation
c) Demand can be synchronized to the clock in the Power Meter.

4) Sampling

a) The current and voltage signals shall be digitally sampled at a rate high enough to provide true rms accuracy to the 63rd harmonic (fundamental of 60 Hz).

(1) The Power Meter shall provide continuous sampling at a minimum of up to 128 samples/cycle, simultaneously on all voltage and current channels in the meter.

5) Minimum and Maximum Values

a) The Power Meter shall provide a monthly minimum and maximum values for the following parameters:

(1) Voltage L-L

(2) Voltage L-N

(3) Current per phase

(4) Voltage L-L Unbalance

(5) Voltage L-N Unbalance

(6) True Power Factor

(7) Displacement Power Factor

(8) Real Power Total

(9) Reactive Power Total

(10) Apparent Power Total

(11) THD Voltage L-L

(12) THD Voltage L-N

(13) THD Current

(14) Frequency

b) For each min/max value listed above, the Power Meter shall record the following attributes:

(1) Date/Time of the min/max value

(2) Min/Max. Value

(3) Phase of recorded Min/Max (for multi-phase quantities)

c) Minimum and maximum values shall be available via communications and display.

6) Harmonic Resolution

a) Advanced harmonic information shall be available via the Power Meter. This shall include the calculation of the harmonic magnitudes and angles for each phase voltage and current through the 63rd harmonic (31st harmonic for the PM810 with PM810LOG and the PM820).

b) Harmonic information shall be available for all three phases, current and voltage, plus the residual 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 harmonic magnitude shall be reported as a percentage of the fundamental or as a percentage of the rms values, as selected by the user.

7) 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 0-10 amps with the following withstand currents: 15 amp continuous, 50 amp 10 sec per hour, 500 amp 1 sec per hour.

b) Current transformer primaries through 327 kA shall be supported.

8) Voltage Inputs

a) The circuit monitor shall allow connection to circuits up to 600 volts AC without the use of potential transformers. The Power Meter shall also accept voltage inputs from standard instrument potential transformers with 120 volt secondary output. The Power Meter shall support PT primaries through 3.2 MV.

b) The nominal full scale input of the circuit monitor shall be 347 Volts AC L-N, 600 Volts AC L-L. The meter shall accept a metering over-range of 50%. The input impedance shall be greater than 2 Ohm.

9) Accuracy

a) The Power Meter shall comply with ANSI C12.20 Class 0.2 and IEC 62053-22 Class 0.5S for Active Energy and revenue meters.

b) The Power Meter shall be accurate to 0.15% of reading + 0.015% of full scale for power. Voltage and current shall be accurate to 0.075% of reading plus 0.025% of full scale. Power factor metering shall be accurate to ±0.002 from 0.5 leading to 0.5 lagging. Frequency metering shall be accurate ±0.01 Hz at 45-67 Hz and 350-450Hz.

c) These accuracies shall be maintained for both light and full loads.

d) No annual calibration shall be required to maintain this accuracy.

10) Waveform Capture

The Power Meter shall provide waveform captures of the voltage and current channels. Waveform capability shall permit to configure the number of captured cycles depending on the sampling rate and channels. The waveforms shall be configurable from one hundred eighty five (185) cycles in one (1) channel at sixteen (16) samples/cycle up to three (3) cycles in six (6) channels at one hundred twenty eight (128) samples/cycle. Waveform captures can be initiated with alarms or manualusing software. (Waveform capture is three (3) cycles fixed at one hundred twenty eight (128) samples/cycle with PM850. And the PM820 or PM810 do not include waveform capability).

a) The Power Meter shall be able to capture, and store in internal non-volatile memory, one hundred twenty eight (128) digitally sampled data points for each cycle of each phase voltage. The number of waveform captures stored onboard the circuit monitor shall be at least five (5).
b) The Power Meter shall transmit the waveform samples over the network to the personal computer workstation for display, archival, and analysis.
c) Harmonic analysis performed on the captured waveforms shall resolve harmonics through the 63rd (PM870 and PM850) or up to the 31st for the PM820 and PM810 with PM810Log module.
d) The data used for the three (3) cycle waveform capture display shall also be used to derive metered quantities in order to provide meaningful additional data.
e) All waveforms must reflect actual circuit performance. Waveforms synthesized or composed over time shall not be acceptable.

11) Input/Output

a) The Power Meter shall supply one (1) digital input and one (1) digital solid state output/KY pulse output as standard.
b) 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 energy. Minimum relay life shall be in excess of one billion operations. The standard KY output shall operate up to 240 volt AC, 300 volt DC, 96mA max, and provide 3750 volt rms isolation.
c) The Power Meter shall support multiple input/output options including digital inputs, mechanical relay outputs, analog inputs, and analog outputs. This optional I/O shall

be in the form of an option module that can be field installable.

d) The digital inputs shall have four operating modes:

(1) Normal mode for simple on/off digital inputs

(2) Demand Interval Synch Pulse to accept a demand synch pulse from a utility demand meter

(3) Conditional Energy Control input to control conditional energy accumulation.

e) Input Metering Demand (WAGES) The power meter shall include five input pulse metering channels. Each channel shall be able to add the consumption signals from one of more digital inputs available in the unit.

f) The Power Meter shall be able to perform GPS time synchronization via any digital inputs.

g) The optional relay output module shall provide a load voltage range from 20 to 240 VAC or from 20 to 30 VDC. It shall support a load current of 2A.

12) Output Relay Control

a) Relay outputs shall operate either by user command sent over the communication link, or in response to a user defined alarm or event.

b) Output relays will have normally open and normally closed contacts and can be configured to operate in several modes:

(1) Normal contact closure where the contacts change state for as long as the signal exists

(2) Latched mode when the contacts change state when a pick-up signal is received and hold until a dropout signal is received.

(3) Timed mode when the contacts change state upon receipt of a pick-up signal and are held for a pre-programmed duration.

(4) End of Power Demand Interval when the relay operates as a synch pulse for other devices.

(5) Energy pulse output. The Relay will pulse quantities used for Absolute kWh, Absolute kVARh,

kVAh, kWh In, kVARh In, kWh Out and kVARh Out

c) It shall be possible for individual relay outputs to be controlled by multiple alarms using Boolean type logic (PM850 & PM870).

13) Logging

a) The Power Meter shall provide for onboard data logging. Each Power Meter shall be able to log data, alarms and events, and waveforms. The Meter shall offer 800kB (80kb on PM820 and PM810 with PM810LOG) of on-board nonvolatile memory. Logged information to be stored in each Power Meter includes the following:

(1) Billing Log: The Power Meter shall store in non-volatile memory a configurable billing log that is updated every fifteen (15) minutes. Data shall be recorded by month, day and fifteen (15) minute interval. The log shall contain twenty four (24) months of monthly data, thirty two (32) days of daily data and between two (2) days to fifty two (52) days of fifteen (15) minute interval data depending on the number of quantities selected.

(2) Custom Data Logs: The Power Meter shall provide 1 data log (the PM810 with PM810LOG and the PM820) or up to four (4) separate data logs (PM850 & PM870), configurable by the user. Each log entry shall be date and time stamped to the second. Each log entry shall hold data of up to ninety six (96) parameters each. It shall be possible to set up each log to take data at a different user defined schedule interval. In addition, it shall be possible for a user to define an event. Data logs can be configured by users to be Fill & Hold or Circular (FIFO). At least one (1) data log shall support log intervals as short as one (1) second.

(3) Alarm Log: This log shall contain time, date, event information, and coincident information for each user defined alarm or event. (PM810 with PM810LOG)

(4) Waveform Logs (PM850 and PM870 only): This log shall store captured waveforms. Waveform logs

shall be either Fill & Hold or Circular (FIFO) as defined by the user.

b) The Power Meter shall have default values for all logs loaded at the factory and begin on device power up.

14) Alarming

a) Alarm events shall be user definable.
b) The user shall be able to define over fifty (50) alarm conditions.
c) The following 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) Voltage imbalance

(7) Over kW Demand

(8) Phase reversal

(9) Digital Input OFF/ON

(10) End of incremental energy interval

(11) End of demand interval

(12) Voltage sag/swell (PM870)

d) For each over/under metered value alarm, the user shall be able to define a pick-up, drop-out, and delay.
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 front panel.
g) The Power Meter shall provide Boolean alarms in the form of combine up to four other alarms with NAND, NOT, OR, and XOR (PM850 & PM870 only)

h) The Power Meter shall perform Power Quality evaluations and issue alarms according to the EN50160, SEMI F47 or ITI(CBEMA) standards (PM850 and PM870 only).
i) The Power Meter shall provide Disturbance alarms for Sag and Swells and be able to enable I/O functionality, data log entry, and perform waveform captures (PM870 only).

15) 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 using Boolean type logic (PM850 & PM870).

16) Feature Addition

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 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.

17) Control Power

a) The Power Meter shall operate properly over a wide range of control power including 90-457 VAC or 100-300 VDC.

18) Communications

a) The Power Meter shall communicate via RS-485 Modbus or Jbus protocol with a 2-wire or 4-wire connection.
b) The Power Meter shall be able to communicate via RS-232 to a laptop or PC or a 4-wire RS-485 Modbus or Jbus protocols when a remote display is included.
c) Using an optional Ethernet Communication Card, the Power Meter shall provide 10/100baseTX Ethernet communications utilizing TCP/IP. Supported protocols

shall include Modbus TCP/IP, HTTP, SMTP, SNMP, SNTP, UDP and FTP.

(1) The Power Meter shall provide the capability to serve as a Modbus master and communicate to thirty one (31) additional Modbus devices connected to an RS-485 daisy chain. The Power Meter shall provide a direct connection between sub-devices and application software across the Ethernet network via ModbusTCP/IP.

(2) The Power Meter shall have the capability to serve data over the Ethernet network accessible through a standard web browser. Information shall be available from the Power Meter and from Modbus sub-devices connected downstream from the interface card. The Power Meter shall contain default web pages from the factory and also allow the user to create web pages as needed.

(3) The Power Meter shall provide an SNMP solution with meter specific custom MIB and MIB 2 support as well as traps for alarms.

(4) The Power Meter shall allow time synchronization via the Ethernet network to one (1) second accuracy or better utilizing SNTP.

(5) The Power Meter shall provide the ability to announce alarms via e-mail utilizing SMTP. The e-mail shall be compatible with paging and text messaging systems allowing users to receive alarm notification on a standard cellular phone. The e-mail notification shall support authentication providing a user defined user's name and password to the e-mail server.

(6) The Power Meter Ethernet Communication Card shall be fully upgradeable in the field across the Ethernet network utilizing FTP. No special software shall be required to upgrade the Ethernet Communications Card. 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.

19) Display

a) The Power Meter display shall allow the user to select among five different languages to view on the screen.

b) The display shall include two different modes of visualization, IEEE and IEC for all quantities.

c) The Power Meter display shall be back lit LCD for easy viewing, display shall also be anti-glare and scratch resistant

d) 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.

e) The Power Meter display shall provide local access to the following metered quantities:

(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

f) Reset of the following electrical parameters shall also be allowed from the Power Meter display:

(1) Peak demand current

(2) Peak demand power (kW) and peak demand apparent power (kVA)

(3) Energy (MWh) and reactive energy (MVARh)

g) Setup for system requirements shall be allowed from the Power Meter display. Setup provisions shall include:

(1) CT rating

(2) PT rating

(3) System type three-phase, 4-wire

(4) Watt-hours per pulse

h) The Power Meter remote display shall be Type 12 compliant (remote display only).

20) The Power Meter shall comply with the following standards:

a) ANSI 12.20 Class 0.2 – Active Energy
b) IEC 62053-22 Class 0.5S– Active Energy
c) IEC 62053-23 Class 2.0 – Reactive Energy
d) IEC 61557-12 – PMD/SD/K70/0.5 and PMD/SS/K70/0.5
e) IEC 61010-1 – Safety
f) UL508 and CSA C22.2 No.14 – Safety
g) Emissions

(1) Radiated - FCC part 15 Class A, EN55011

(2) Conducted - FCC par 15 Class A, EN55011

(3) Harmonics – IEC 61000-3-2

(4) Flicker – IEC 61000-3-3

h) Immunity

(1) ESD IEC 61000-4-2 Level 3

(2) Radiated IEC 61000-4-3 Level 3

(3) EFT IEC 61000-4-4 Level 3

(4) Surges IEC 61000-4-5 Level 3

(5) Conducted IEC 61000-4-6 Level 3

(6) Magnetic Field IEC 61000-4-8 Level 3

(7) Voltage Dips IEC 61000-4-11 Level 3

(8) Ring Wave IEC 61000-4-12 Level 3

i) ANSI C37.90.1 – Surge withstand capability

j) The Power Meter shall be a PM800 series manufactured by Schneider Electric or equal.

2.4 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."

2.5 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 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.

3.3 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.

3.4 GROUNDING

A. Comply with IEEE 1100, "Recommended Practice for Powering and Grounding Electronic Equipment."

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.

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. 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.

E. Power monitoring and control equipment will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

H. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

I. Reports: Submit written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

J. Remove and replace malfunctioning devices and circuits and retest as specified above and note corrective action in report.

3.6 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.

3.7 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 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. Product Data: Include rated capacities, furnished specialties, and accessories.

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.
2. Dimensioned plans and elevations showing major components and features.
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.

C. Time-Current Characteristic Curves: For overcurrent protective devices.

D. Primary Fuses: Submit recommendations and size calculations.

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. 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.

B. Source Limitations: Obtain secondary unit substation through one source from a single manufacturer.

C. 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."

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.

F. Comply with IEEE C37.121.

G. 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.

C. Service Conditions: IEEE C37.121, usual service conditions, except for the following:
1. Unusual transportation or storage conditions.
2. Unusual space limitations.
3. Unusual access limitations.

1.8 COORDINATION

A. Coordinate layout and installation of secondary unit substations with other construction, including light fixtures, HVAC equipment, and fire-suppression-system components.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

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: Three half-pint containers of paint matching enclosure's exterior finish.
4. Primary Switch Contact Lubricant: One container(s).
5. One set(s) 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; Cutler-Hammer.
2. Square D; Schneider Electric.

2.2 MANUFACTURED UNITS

A. Indoor Unit Arrangement: Single assembly.

B. Enclosure Finish: Factory-applied finish in manufacturer's standard color, including under surfaces treated with corrosion-resistant undercoating.

2.3 INCOMING SECTION

A. Primary Incoming Section: Enclosed, air-interrupter, primary switch.

1. Three pole, single throw, dead front, metal enclosed, with manual stored energy operator, frame complying with IEEE C37.20.3.
2. Key interlocking system to prevent fuse access door from being opened unless switch is open
3. Allow non-interlock operation of dual primary switches.
4. 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.
5. IR Port: 3 inches.
6. Window: Permits viewing switch-blade positions when door is closed.
7. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.
8. Continuous-Current Rating: 600 A.
9. Short-Circuit Rating:

    a. Short-time momentary asymmetrical fault rating of 40 kA.
    b. 2-second symmetrical rating of 25-kA RMS.
    c. Fault close asymmetrical rating of 40 kA.

10. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading. Comply with the following:

    a. Current-limiting type, rated for not less than 50-kA RMS symmetrical current-interrupting capacity.
    b. Indicator integral with each fuse to show when it has blown.
    c. 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: IEEE C57.12.01, NEMA ST 20, and dry-type, 2-winding, secondary unit substation transformer.

B. Enclosure: Indoor, 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 40^0 C.

C. Cooling System: Class AA, air cooled complying with IEEE C57.12.01.

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.

I. Impedance: 5.75 percent.

J. 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.

2.5 SECONDARY DISTRIBUTION SECTION

A. Secondary Distribution: Low-voltage switchboard as specified in Division 26 Section "Switchboards."

2.6 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."

2.7 SOURCE QUALITY CONTROL

A. Factory Tests: Perform the following factory-certified tests on each secondary unit substation:

1. Resistance measurements of all windings on the rated voltage connection and on tap extreme connections.
2. Ratios on the rated voltage connection and on tap extreme connections.
3. Polarity and phase relation on the rated voltage connection.
4. No-load loss at rated voltage on the rated voltage connection.

5. Exciting current at rated voltage on the rated voltage connection.
6. Impedance and load loss at rated current on the rated voltage connection and on tap extreme connections.
7. Applied potential.
8. Induced potential.

9. Owner will witness all required factory tests. Contractor to provide accommodations if more than 50 mi from site. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

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.

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.

C. Provide updated new one line diagram.

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 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.

3.7 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

SECTION 262300 - LOW-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.

1.2 SUMMARY

A. This Section includes metal-enclosed, low-voltage power circuit-breaker switchgear rated 1000 V and less for use in ac systems.

B. Related Sections include the following:

1. Division 26 Section "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.

1.3 DEFINITIONS

A. ATS: Acceptance Testing Service.

B. GFCI: Ground-fault circuit interrupter.

1.4 SUBMITTALS

A. Product Data: For each type of switchgear, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each type of switchgear and related equipment.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:

a. Tabulation of installed devices with features and ratings.
b. Enclosure types and details.
c. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
d. Bus configuration with size and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.

e. Current rating of buses.
f. Short-time and short-circuit current rating of switchgear assembly.
g. Nameplate legends.
h. Mimic-bus diagram.
i. Utility company's metering provisions with indication of approval by utility company.
j. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where pipe 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. Indicate field measurements.

D. Samples: Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.

E. Qualification Data: For testing and inspection agencies.

F. Field quality-control test reports.

G. Updated mimic-bus diagram reflecting field changes after final switchgear load connections have been made, for record.

H. Operation and Maintenance Data: For switchgear 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 testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 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. Source Limitations: Obtain switchgear through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear 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 NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchgear in sections of lengths that can be moved past obstructions in delivery path.

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. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.

B. 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 10 days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without UM’s written permission.

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. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not exceeding 40^0C.
2. Altitude: Not exceeding 6600 feet.

1.8 COORDINATION

A. Coordinate layout and installation of switchgear and components with other construction that penetrates ceilings or is supported by them, 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: Six of each type and rating used. Include spares for potential transformer fuses, control power fuses, and fuses and fusible devices for fused circuit breakers.
2. Indicating Lights: Six of each type installed.
3. Touchup Paint: 3 containers of paint matching enclosure finish, each 0.5 pint.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Square D; Schneider Electric.
2. Cutler-Hammer, Inc.; Eaton Corporation.

2.2 RATINGS

A. Nominal System Voltage: 480/277 V, 4 wire, 60 Hz.

B. Main-Bus Continuous: 2000A.

C. Short-Time and Short-Circuit Current: Match rating of highest-rated circuit breaker in switchgear assembly.

2.3 FABRICATION

A. Factory assembled and tested and complying with IEEE C37.20.1.

B. Indoor Enclosure Material: Steel.

C. Finish: IEEE C37.20.1, manufacturer's standard gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces.

D. Section barriers between main and tie circuit-breaker compartments shall be extended to rear of section.

E. Bus isolation barriers shall be arranged to isolate line bus from load bus at each main and tie circuit breaker.

F. Circuit-breaker compartments shall be equipped to house drawout-type circuit breakers and shall be fitted with hinged outer doors.

G. Fabricate enclosure with removable, hinged, rear cover panels to allow access to rear interior of switchgear.

H. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following:

1. Utility metering compartment that complies with utility company requirements.
2. Bus transition sections.
3. Incoming-line pull sections.
4. Hinged front panels for access to metering, accessory, and blank compartments.
5. Pull box on top of switchgear for extra room for pulling cable, with removable top, front, and side covers and ventilation provisions adequate to maintain air temperature in pull box within same limits as switchgear.

    a. Set pull box back from front to clear circuit-breaker lifting mechanism.
    b. Bottom: Insulating, fire-resistant material with separate holes for cable drops into switchgear.
    c. Cable Supports: Arranged to ease cabling and adequate to support cables indicated, including those for future installation.

I. Bus bars connect between vertical sections and between compartments. Cable connections are not permitted.

1. Main Phase Bus: Uniform capacity the entire length of assembly.
2. Neutral Bus: 100 percent of phase-bus ampacity, except as indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors. Include braces for neutral-bus extensions for busway feeders.
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- and Neutral-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.
   Revise subparagraph below to select Copper-plated bus when not in a corrosive environment.
6. Contact Surfaces of Buses: Silver plated copper.
7. Feeder Circuit-Breaker Load Terminals: Silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.
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.
9. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.
10. Neutral bus equipped with pressure-connector terminations for outgoing circuit neutral conductors. Neutral-bus extensions for busway feeders are braced.
11. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch copper bus, arranged to connect neutral bus to ground bus.
12. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
13. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation.

    a. Sprayed Insulation Thickness: 3 mils, minimum.
    b. Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

2.4 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: Ratios as indicated; 0-5 amp secondary with 0.3% accuracy, burden suitable for connected relays, meters, and instruments.

B. Multifunction Digital-Metering Monitor: See Division 26 Section "Electrical Monitoring and Control":

C. Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.

D. Surge Arresters: Distribution class, metal-oxide-varistor type. Comply with IEEE C62.11 and NEMA LA 1.

1. Install in cable termination compartments and connect in each phase of circuit.

2. Coordinate rating with circuit voltage.

E. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.

F. Control Power Supply: Constant-voltage control power transformer supplying 120-V control circuits through secondary disconnect devices. Include the following features:

1. Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
2. Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker.

a. Secondary windings connected through a relay or relays to control bus to effect an automatic transfer scheme.
b. Secondary windings connected through an internal automatic transfer switch to switchgear control power bus.

3. Control Power Fuses: Primary and secondary fuses with current-limiting and overload protection.
4. Fuses are specified in Division 26 Section "Fuses."

G. 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.

2.5 CIRCUIT BREAKERS

A. Description: Comply with IEEE C37.13.

B. Ratings: As indicated for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear.

C. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:

1. Normal Closing Speed: Independent of both control and operator.
2. Slow Closing Speed: Optional with operator for inspection and adjustment.
3. Stored-Energy Mechanism: Electrically charged, with optional manual charging.
4. Operation counter.

D. 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:

1. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
2. Temperature Compensation: Ensures accuracy and calibration stability from minus 5^0C to plus 40^0C.
3. Field-adjustable, time-current characteristics.
4. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or a combination of these methods.
5. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
6. Pickup Points: Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I^2t operation.
7. Pickup Points: Five minimum, for instantaneous-trip functions.
8. Ground-fault alarming with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup. Arrange to provide protection for the following:
    a. Four-wire, double-ended substation.
9. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.

E. Auxiliary Contacts: For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated. Each consists of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to a terminal block in stationary housing.

F. 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:

1. 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.
2. Circuit-Breaker Positioning: An open circuit breaker shall be racked to or from connected, test, and disconnected positions only with the associated compartment door closed unless live parts are covered by a full dead-front shield. An open circuit breaker may be manually withdrawn to a position for removal from the structure with the door open. Status for connection devices for different positions includes the following:
    a. Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.

b. Disconnected Position: Primary and secondary devices and ground contact disengaged.

G. 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.

H. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.

I. Operating Handle: One for each circuit breaker capable of manual operation.

J. Electric Close Button: One for each electrically operated circuit breaker.

K. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.

L. Key Interlocks: Arranged so keys are attached at devices indicated. Mountings and hardware are included where future installation of key-interlock devices is indicated.

M. Undervoltage Trip Devices: Adjustable time-delay and pickup voltage.

N. Shunt-Trip Devices: Where indicated.

O. Indicating Lights: Separate indicating lights for circuit breaker is open or closed, for feeder, main and bus tie circuit breakers.

2.6 ACCESSORIES

A. Accessory Set: 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.
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.

B. 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.

C. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.

D. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

2.7 IDENTIFICATION

A. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved 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 selected by Architect.
3. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer's full range.

B. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:

1. Frame size of each circuit breaker.
2. Trip rating for each circuit breaker.
3. Conduit and wire size for each feeder.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces where switchgear will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with applicable portions of NECA 400.

B. Anchor switchgear assembly to 6-inch, channel-iron floor 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: 6 inches high, reinforced, with chamfered edges. Extend base no more than 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."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, 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 and mount under clear acrylic plastic on the 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. 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 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect switchgear installation, including wiring, components, connections, and equipment. Test and adjust components and equipment.
2. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.
3. Complete installation and startup checks according to manufacturer's written instructions.

4. Assist in field testing of equipment including pretesting and adjusting of equipment and components.
5. Report results in writing.

B. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for 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.

2. Remove and replace malfunctioning units and retest as specified above.

C. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an 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 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 scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable, protective-relay trip characteristics according to results in Division 26 Section "Overcurrent Protective Device Coordination Study."

B. Set field-adjustable, protective-relay trip characteristics.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of switchgear. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.8 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 manufacturer's stipulated service conditions.

3.9 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 262300

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 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. Refer to Part 3 for additional requirements.

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.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. 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.

1.6 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.

1.7 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.
4. The operation of electrical panels or power switches; required to achieve an outage must be accomplished by University personnel only. Unauthorized operation of electric panels, power switches, by contractors their personnel will result in extremely serious consequences for which the contractor will be held accountable.

5. Mandatory Requirements: The following requirements are mandatory:

a. 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.

b. 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.

6. Electrical contractor shall identify existing circuits and existing panels for the renovation area and trace and identify existing circuits. Identifying and tracing of the circuits shall be done with machinery and appropriate safety gear. Should an outage become necessary, it will need to be requested a minimum of ten (10) working days in advance through the UMB Project Manager.

1.8 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.

1.9 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.

1.10 EXTRA MATERIALS

A. Coordinate with Division 26 Section "Fuses" for quantities of spare fuses and spare-fuse cabinet to be provided.

B. 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: Two spares for each panelboard.
3. Provide and install fuse cabinet.

1.11 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 indoor construction location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1

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.

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.

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.

H. Branch Circuit Panelboard Sizing and Capacity: Regardless of purpose/function, provide minimum 225amp (208V) and minimum 250amp (480V) rated panels with minimum forty two (42) poles. For panels that are greater than forty two (42) poles, provide a minimum eighty four (84) pole panel. De-rated 85, 100, or 150amp panels are prohibited.

I. Wall-mounted Distribution Panels/Boards: Provide distribution panels with a minimum 99” of breaker mounting space (i.e. the combined vertical mounting space on both left and right sides) and with the minimum breaker capacity or prepared spaces for installing 400A and/or 600A branch circuit breakers in the future.

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. 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: Bolt-on 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.

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. 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. Square D; a brand of Schneider Electric.
3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

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. 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. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.

e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off 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. Equipment Mounting: Install panelboards on concrete bases, four (4) inch nominal thickness.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on eighteen (18) inch centers around full perimeter of base.
2. For panelboards, 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 panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Mount top of trim 90 inches above finished floor unless otherwise indicated.

E. 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.

F. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

G. Install filler plates in unused spaces.

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. Contractor shall also provide an electronic copy of new and/or revised schedule in excel or word format to Operations & Maintenance work management system thru Director of Operations & Maintenance.

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 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262419 - MOTOR-CONTROL CENTERS

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 MCCs for use with ac circuits rated 600 V and less, with combination controllers and having the following factory-installed components:
   1. Measurement and control.
   2. Auxiliary devices.

1.3 DEFINITIONS

A. CPT: Control power transformer.

B. MCC: Motor-control center.

C. MCCB: Molded-case circuit breaker.

D. MCP: Motor-circuit protector.

E. OCPD: Overcurrent protective device.

F. PID: Control action; proportional plus integral plus derivative.

G. PT: Potential transformer.

H. SPD: Surge protective device.

I. SCR: Silicon-controlled rectifier.

J. VFC: Variable-frequency controller.

K. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for MCCs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories for each cell of the MCC.

B. Shop Drawings: For each MCC, manufacturer's approval drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

1. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.
b. Factory-installed devices.
c. Enclosure types and details.
d. Nameplate legends.
e. Short-circuit current (withstand) rating of complete MCC, and for bus structure and each unit.
f. Features, characteristics, ratings, and factory settings of each installed controller and feeder device, and installed devices.
g. Specified optional features and accessories.

2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring for each installed controller.
3. Nameplate legends.
4. Vertical and horizontal bus capacities.
5. Features, characteristics, ratings, and factory settings of each installed unit.

1.5 INFORMATIONAL SUBMITTALS

A. Standard Drawings: For each MCC, as defined in UL 845.

B. Production Drawings: For each MCC, as defined in UL 845.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around MCCs where pipe and ducts are prohibited. Show MCC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Qualification Data: For testing agency.

E. Product Certificates: For each MCC.

F. Source quality-control reports.

G. Field quality-control reports.

H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

I. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For MCCs, all installed devices, and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
2. Manufacturer's Record Drawings: As defined in UL 845. In addition to requirements specified in UL 845, include field modifications and field-assigned wiring identification incorporated during construction by manufacturer, Contractor, or both.
3. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
4. Manufacturer's written instructions for setting field-adjustable overload relays.
5. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage, solid-state controllers.
6. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
7. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

1.7 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. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

3. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain MCCs and controllers of a single type from single source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, and marked for intended use.

D. UL Compliance: MCCs shall comply with UL 845 and shall be listed and labeled by a qualified testing agency.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver MCCs in shipping splits of lengths that can be moved past obstructions in delivery paths.

B. Handle MCCs according to the following:

1. NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."
2. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."

C. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside MCCs; install temporary electric heating, with at least 250 W per vertical section.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace MCC and SPD that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

    a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    b. Square D; a brand of Schneider Electric.

2.2 SYSTEM DESCRIPTION

A. NEMA Compliance: Fabricate and label MCCs to comply with NEMA ICS 18.

B. Ambient Environment Ratings:

1. Ambient Temperature Rating: Not less than 0 deg F and not exceeding 104 deg F, with an average value not exceeding 95 deg F over a 24-hour period.
2. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F
3. Humidity Rating: Less than 95 percent (noncondensing).
4. Altitude Rating: Not exceeding 6600 feet, or 3300 feet if MCC includes solid-state devices.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 PERFORMANCE REQUIREMENTS

A. Capacities and Characteristics:

1. MCC Enclosure and Assembly:

    a. Nominal System Voltage: 480V ac.
    b. Service Equipment Rated: Yes
    c. Enclosure: NEMA 250, Type 1

2. Integrated Short-Circuit Rating for MCC:
    a. Fully rated; 42 kA.

3. Integrated Short-Circuit Rating for Each Unit:
   a. Fully rated; 42 kA.

4. Wiring Class: Class A
5. Bus:

   a. Horizontal Bus: 600A.
   b. Neutral Bus: None

6. Main Disconnect Device:

   a. Main Disconnect: MCCB, UL 489.
   b. SPD: UL 1449, Type 2
7. Magnetic Controllers:
   a. Classification by Starting Method: FVNR
   b. Controller Size: Refer to drawings, complying with NEMA ICS 2.

2.4 MOTOR CONTROL CENTER ENCLOSURES

A. Indoor Enclosures: Freestanding steel cabinets unless otherwise indicated. NEMA 250, Type 1 unless otherwise indicated to comply with environmental conditions at installed location.

2.5 ASSEMBLY

A. Structure:

1. Comply with UL requirements for service entrance equipment.
2. Units up to and including Size 3 shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
3. Units in Type B and Type C MCCs shall have pull-apart terminal strips for external control connections.
4. Pull Boxes:

   a. Include provisions for ventilation to maintain temperature in pull box within same limits as the MCC.
   b. Set the box back from front to clear circuit-breaker removal mechanism.
   c. Covers: Removable covers forming top, front, and sides.
   d. Insulated bottom of fire-resistive material with separate holes for cable drops into MCC.
   e. Cable Supports: Arranged to facilitate cabling and adequate to support cables, including supports for future cables.

f. When equipped with barriers, supply with access to check bus bolt tightness.

B. Compartments: Modular; individual lift-off doors with concealed hinges and quick-captive screw fasteners.

1. Interlock compartment door to require that the disconnecting means is "off" before door can be opened or closed, except by operating a concealed release device.
2. Compartment construction shall allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC.
3. The same-size compartments shall be interchangeable to allow rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.

C. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC; same-size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.

D. Wiring Spaces:

1. Vertical wireways in each vertical section for vertical wiring to each unit compartment; supports to hold wiring in place.
2. Horizontal wireways in top of each vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.

E. Provisions for Future:

1. Compartments marked "future" shall be bused, wired and equipped with guide rails or equivalent, and ready for insertion of drawout units.
2. Compartments marked "spare" shall include provisions for connection to the vertical bus.

F. Integrated Short-Circuit Rating:

1. Short-Circuit Current Rating for Each Unit: Fully rated. 42kA.
2. Short-Circuit Current Rating of MCC: Fully rated with its main overcurrent device 42kA.

G. Control Power:
1. 24-V ac; obtained from CPT integral with controller; with primary and secondary fuses. The CPT shall be of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

a. CPT Spare Capacity: 100VA.

H. Factory-Installed Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

1. Wiring Class: NEMA ICS 18, Type A

I. Bus:

1. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections. Provide for future extension..
2. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.
3. Phase-Bus Material: Hard-drawn copper of 98 percent minimum conductivity or silver-plated alloy, with mechanical connectors for outgoing conductors.
4. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for ground conductors, minimum size 1/4-by-2 inches. Equip with mechanical connectors for outgoing conductors.

2.6 MAIN DISCONNECT AND OVERCURRENT PROTECTIVE DEVICE(S)

A. MCCB (to 2500 A): Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.

1. MCCB shall have quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, its position shall be shown by the position of the handle, and manual push-to-trip push button.
2. Solid-state monitoring and tripping system to show system status monitoring, adjustable time-current protection, and shunt trip.

a. Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
b. Trip-setting dials or interchangeable plugs to establish the continuous trip of the circuit breaker. Plugs shall not be interchangeable between frames, and the breaker may not be closed without the plug. With neutral ground-fault sensor.
c. Time-current adjustments to achieve protective-device coordination as follows:

a. Adjustable long-time delay.
b. Adjustable short-time setting and delay to shape the time-current curve.
c. Adjustable instantaneous setting.
d. Individually adjustable ground-fault setting and time delay.

d. Built-in connector to test the long-time delay, instantaneous, and ground-fault functions of the breaker.
e. Built-in digital ammeter display, showing load current and tripping cause.

3. Switch operator power shall be from control power specified in "Assembly" Article.

B. Surge Suppression: Factory installed as an integral part of the incoming feeder, complying with UL 1449, SPD Type 2.

2.7 MAGNETIC CONTROLLERS

A. Controller Units: Combination controllers.

B. Disconnects:

1. MCCB:

a. UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
c. Lockable Handle: For three padlocks and interlocks with cover in closed position.
d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
e. NC alarm contact that operates only when MCCB has tripped.

C. Controllers: Comply with UL 508.

1. Full-Voltage Magnetic Controllers: Electrically held, full voltage, NEMA ICS 2, general purpose, Class A.

a. Classification: Nonreversing

D. Overload Relays:

1. Solid-State Overload Relays:

a. Switch or dial selectable for motor-running overload protection.
b. Sensors in each phase.
c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
d. UL 1053 Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

e. Analog communication module.

2. NC isolated overload alarm contact.
3. External overload reset push button.

2.8 CONTROLLER-MOUNTED AUXILIARY DEVICES

A. Control-Circuit and Pilot Devices: Factory installed in controller enclosure cover unless otherwise indicated. Comply with NEMA ICS 5.

1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.

a. Push Buttons: Recessed types; momentary contact unless otherwise indicated.
b. Pilot Lights: [LED types.
c. Selector Switches: Rotary type.

B. Auxiliary Dry Contacts: NC.

C. Control Relays:

1. Time Delay: Auxiliary and adjustable solid-state time-delay relays.
2. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections and adjustable undervoltage, overvoltage, and time-delay settings.

2.9 SOURCE QUALITY CONTROL

A. MCC Testing: Test and inspect MCCs according to requirements in NEMA ICS 18.

B. MCCs 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 MCCs, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. NEMA Industrial Control and Systems Standards: Comply with parts of NEMA ICS 2.3 for installation and startup of MCCs.

B. Floor Mounting: Install MCCs on 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification of MCC, MCC components, and control wiring.

1. Identify field-installed conductors, interconnecting wiring, and components.
2. Install required warning signs.
3. Label MCC and each cubicle with engraved nameplate.
4. Label each enclosure-mounted control and pilot device.
5. Mark up a set of manufacturer's connection wiring diagrams with field-assigned wiring identifications and return to manufacturer for inclusion in Record Drawings.

B. Operating Instructions: Frame printed operating instructions for MCCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of MCCs.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between controllers, master terminal boards, remote devices and facility's BAS. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
2. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 CONNECTIONS

A. Comply with requirements for installation of conduit in Section 260533 "Raceways and Boxes for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

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

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

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

D. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multipole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multipole enclosed controller 11 months after date of Substantial Completion.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Submit calibration record for device.

5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
6. Mark up a set of manufacturer's drawings with all field modifications incorporated during construction and return to manufacturer for inclusion in Record Drawings.

F. MCCs will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.7 STARTUP SERVICE

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

1. Complete installation and startup checks according to NETA Acceptance Testing Specification and manufacturer's written instructions.

3.8 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload relay pickup and trip ranges.

B. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load

amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Owner before increasing settings.

C. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Studies."

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION 262419

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 and associated device plates.
2. Snap switches.

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 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).

2.5 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.~~

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant thermoplastic with lockable cover.

2.6 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 ensure 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. 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.

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. Test Instruments: Use instruments that comply with UL 1436.
2. 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 262923 - VARIABLE-FREQUENCY DRIVES

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 separately enclosed, pre-assembled, combination VFDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CPT: Control power transformer.

C. EMI: Electromagnetic interference.

D. IGBT: Insulated-gate bipolar transistor.

E. LAN: Local area network.

F. LED: Light-emitting diode.

G. MCP: Motor-circuit protector.

H. NC: Normally closed.

I. NO: Normally open.

J. OCPD: Overcurrent protective device.

K. PCC: Point of common coupling.

L. PID: Control action, proportional plus integral plus derivative.

M. PWM: Pulse-width modulated.

N. RFI: Radio-frequency interference.

O. TDD: Total demand (harmonic current) distortion.

P. THD(V): Total harmonic voltage demand.

Q. VFD: Variable-frequency motor controller.

R. VFD: Variable-frequency drive (synonymous with VFD).

1.4 SUBMITTALS

A. Product Data: For each type and rating of VFD indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.

B. LEED Submittals:

1. Product Data for Credit EA 5: For continuous metering equipment for energy consumption.

C. Shop Drawings: For each VFD indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

1. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.
b. Factory-installed devices.
c. Enclosure types and details.
d. Nameplate legends.
e. Short-circuit current (withstand) rating of enclosed unit.
f. Features, characteristics, ratings, and factory settings of each VFD and installed devices.
g. Specified modifications.

2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

D. Harmonic Analysis Study and Report: Comply with IEEE 399 and NETA Acceptance Testing Specification; identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for VFD input filtering to limit TDD and THD (V) at each VFD at the defined PCC to specified levels.

1. Harmonic Calculations: The VFD manufacturer shall supply harmonic calculations made in accordance with the latest version of IEEE 519 showing the specified THVD, line notching and the specified THCD limits are met. Calculations shall assume worst case system conditions. System single-line, 480V transformer data, generator data and primary fault current data can be found in the Overcurrent Protective Device Coordination Study and can be obtained from the Electrical Contractor. The calculations shall include:

   a. All input data and assumptions

   b. Explanation of method used to perform the analysis

   c. All calculations and computer printouts used in the analysis, including input documentation

   d. A system impedance diagram based on Electrical single-line diagram

   e. All calculations shall be made in accordance with IEEE 519 with all drives at 100% speed. The point of common coupling shall be the primary connection of the transformer supplying that group of devices. These calculations shall be done with the transformer loaded to no more than 70% of its nominal capacity. These calculations shall also be done with all 12-pulse or greater drives running as well as the smaller drives running.

   f. A detailed description of the tests, procedures and supporting calculations required to substantiate the installed systems compliance with the THD limits.

      1) The description shall include information on the proposed test equipment and test conditions.

      2) Include the name and qualifications of the firm which will conduct the field test.

   g. Each point of common coupling shall be defined as the primary of the side of the transformer that feeds that group of drives. At the point of common coupling, the following numbers shall meet with the maximum load on the transformer no greater than 70% of its nominal capacity.
      1) Total harmonic voltage distortion is less than 3%
      2) Total harmonic current distortion is less than 5% and harmonic table requirements $I_{sc}/I_L<20$.

      Note: Six (6) Pulse drives will not be accepted for over 175hp drives, even if this calculation is met.

   h. Submittals without calculations will not be reviewed

E. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFDs. Show VFD layout and relationships between electrical components and adjacent structural and

mechanical elements including raceway stub-ups and field wiring. Show support locations, type of support, and weight on each support. Indicate field measurements.

F. Qualification Data: For qualified testing agency.

G. Product Certificates: For each VFD, from manufacturer.

H. Source quality-control reports.

I. Field quality-control reports.

J. Operation and Maintenance Data: For VFDs 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 thermal-magnetic circuit breaker and MCP trip settings.
2. Manufacturer's written instructions for setting field-adjustable overload relays.
3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

K. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.

L. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental and Operating Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 0^0F and not exceeding 120^0F.
2. Ambient Storage Temperature: Not less than minus 4^0F and not exceeding 140^0F
3. Humidity: Less than 95% (noncondensing and non-corrosive).
4. Altitude: Not exceeding 3300 feet.
5. Incoming 3-phase 480 VAC power: +5% or -10% at 60 Hz.
6. A 50% voltage sags for thirty (30) cycles.

B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in 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 Architect no fewer than ten (10) days in advance of proposed interruption of electrical systems.
2. Indicate method of providing temporary electrical service.
3. Do not proceed with interruption of electrical systems without Owner's written permission.
4. Comply with NFPA 70E.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, including clearances between VFDs, and adjacent surfaces and other items.

1.7 COORDINATION

A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:

1. Torque, speed, and horsepower requirements of the load.
2. Ratings and characteristics of supply circuit and required control sequence.
3. Ambient and environmental conditions of installation location.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

D. Submit written, signed off coordination statement confirming input control signal is compatible with automatic controls and/or building automation control system.

1.8 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. Power Fuses: Equal to Five (5) percent of quantity installed for each size and type, but no less than one of each size and type.
2. Control Power Fuses: Equal to five percent of quantity installed for each size and type, but no less than one of each size and type.
3. Indicating Lights: One of each type and color installed.
4. Auxiliary Contacts: Furnish One spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish One spares for each size and type of magnetic contactor installed.

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 VFDs that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Five (5)years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Acceptable Manufacturers: Subject to compliance with ANSI, IEEE and NEMA requirements, and unless otherwise indicated all VFD’s shall be products manufactured by one (1) of the following:

1. ABB (Advanced Thermal Solutions @410-247-7901).
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit (Sheppard Electric @410-866-6000).
3. Robicon (Shepherd Electric @410-866-6000).

B. Exception to Acceptable VFD Manufacturers: This exception to the acceptable VFD manufacturers is limited to centrifugal chillers and domestic and/or laboratory water booster pumps only. Variable frequency drives for chillers and domestic water booster pumps shall be products provided by the equipment manufacturer and be factory

mounted. For domestic water booster pumps provide VFD's as manufactured by Danfoss. See mechanical specifications for VFD requirements.

C. General Requirements for VFDs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C

D. Application: Constant torque and variable torque.

E. VFD Description: Variable-frequency power converter (PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency. The VFD shall convert the fixed voltage and frequency available from the utility or campus wide system to a variable voltage and frequency output via a two (2) step operation. VFD's utilizing a third power section will not be acceptable. Efficiency shall exceed 95% at 100% speed and load. Line side displacement power factor shall exceed 0.95 regardless of speed and load. The VFD shall be rated for 110% current for 1 minute for variable torque loads and 150% current for 1 minute for constant torque loads.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

F. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

G. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

H. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10% and minus 15% of VFD input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 5%.
3. Input Frequency Tolerance: Plus or minus 3% of VFD frequency rating.
4. Minimum Efficiency: 96% at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 96% under any load or speed condition.

6. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.
7. Ambient Temperature Rating: Not less than 14^0F and not exceeding 120^0F.
8. Ambient Storage Temperature Rating: Not less than minus 4^0F and not exceeding 140^0F.
9. Humidity Rating: Less than 95% (noncondensing).
10. Altitude Rating: Not exceeding 3300 feet.
11. Vibration Withstand: Comply with IEC 60068-2-6.
12. Overload Capability: 1.5 times the base load current for sixty (60) seconds; minimum of 1.8 times the base load current for three seconds.
13. Starting Torque: Minimum 100% of rated torque from 3 to 60 Hz.
14. Speed Regulation: Plus or minus 5%.
15. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
16. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
17. VFD's above 200hp: 12-Pulse, THVD < 5%, THCD<8% & harmonic table requirements for I_{sc}/I_L =20-50, THD=8.0.
18. VFD's 200hp and Less: 6-Pulse, THVD<5%, THCD<8% & harmonic table requirements for I_{sc}/I_L <20, THD=5.0%.

I. Inverter Logic: Microprocessor based, thirty two (32) bit, isolated from all power circuits.

J. Isolated Control Interface: Allows VFDs to follow remote-control signal over a minimum 40:1 speed range.

1. Signal: Electrical.
2. Signal: Pneumatic.

K. Internal Adjustability Capabilities:

1. Minimum Speed: 5% to 25% of maximum rpm.
2. Maximum Speed: 80% to 100%of maximum rpm.
3. Current Limit: 30% to minimum of 150% of maximum rating.
4. Minimum frequency (4-60 Hz)
5. Maximum frequency (40-120 Hz)
6. Four (4) preset speeds (4-120 Hz) initiated by contact closures
7. Four (4) acceleration times (2-300 seconds)
8. Four (4) de-acceleration times (2-300 seconds)
9. Minimum speed dwell time (0-18 seconds)
10. Voltage boost (0-40V) for starting torque control
11. Adjustable Carrier Frequency (700-10,000 Hz) for motor noise reduction or flexible switching technology. This adjustment shall be without derating the drive or motor.
12. Current Limit (70% - 120%)Critical Frequency Avoidance (2 bands with 10 Hz adjustable widths

L. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide three (3) phase protection against damage from supply voltage surges 10% or more above nominal line voltage.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFD and Motor Overload/Over temperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD over temperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
6. Critical frequency rejection, with three (3) selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor overtemperature fault.
12. <Insert protection or reliability feature>.

M. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

N. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

O. Bidirectional Auto speed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

P. Torque Boost: Automatically varies starting and continuous torque to at least one and one half (1.5) times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

Q. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

R. Integral Input Disconnecting Means and OCPD: NEMA AB 1, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115% of VFD input current rating.
2. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
3. NC alarm contact that operates only when circuit breaker has tripped.

2.2 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.
7. Run/Stop selection and LED indication (keypad or remote)
8. Speed control selection and LED indication
9. Forward/Reverse selection
10. Manual speed adjustment
11. Frequency meter
12. Motor RPM
13. Ammeter
14. Output Voltage
15. Elapse Time Meter

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

    a. Control Authority: Supports at least four conditions: Off, local manual control at VFD, local automatic control at VFD, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four (4) faults with time and date stamp for each.

D. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFD door and connected to display VFD parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:

   a. A minimum of two (2) programmable analog inputs: 0- to 10-V dc.
   b. A minimum of six (6) multifunction programmable digital inputs.

2. Pneumatic Input Signal Interface: 3 psig to 1**5** psig.

3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:

   a. RS485
   b. Keypad display for local hand operation.
   c. 0- to 10-V dc.
   d. 4- to 20-mA dc.
   e. Potentiometer using up/down digital inputs.
   f. Fixed frequencies using digital inputs.

4. Output Signal Interface: A minimum of two (2) programmable analog output signal(s), 0- to 10-V dc, which can be configured for any of the following:

   a. Output frequency (Hz).
   b. Output current (load).
   c. DC-link voltage (V dc).
   d. Motor torque (percent).
   e. Motor speed (rpm).
   f. Set point frequency (Hz).
   g. <Insert indication>.

5. Remote Indication Interface: A minimum of two (2) programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

   a. Motor running.
   b. Set point speed reached.

c. Fault and warning indication (overtemperature or overcurrent).
d. PID high- or low-speed limits reached.
e. <Insert indication>.

F. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFD status, alarm and energy usage. Allows VFD to be used with an external system within a multidrop LAN configuration; settings retained within VFD's nonvolatile memory.

1. Network Communications Ports: RS-/485.
2. Embedded BAS Protocols for Network Communications: ASHRAE 135 BACnet; protocols accessible via the communications ports.

2.3 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD and THD(V) at the defined PCC per IEEE 519.

B. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2

2.4 BYPASS SYSTEMS

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.

C. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller ; with input isolating switch and barrier arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.

1. Bypass Contactor: Load-break, NEMA-rated contactor.
2. Input and Output Isolating Contactors: Non-load-break, NEMA-rated contactors.
3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

4. Overload Relays: NEMA ICS 2.

a. Solid-State Overload Relays:

1) Switch or dial selectable for motor-running overload protection.
2) Sensors in each phase.
3) Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
5) Analog communication module.

b. NC isolated overload alarm contact.

c. External overload reset push button.

2.5 ENCLOSURES

A. VFD Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.
2. Mechanical and Electrical Rooms: NEMA Type 12.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFD as "Plenum Rated."

2.6 ACCESSORIES Match to Enclosed Controllers

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFD enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty type.

a. Push Buttons: Shielded types; momentary.
b. Pilot Lights LED types; Green for de-energized state, red for energized state, amber for warning and white for alarm, push to test.
c. Selector Switches: Rotary type.
d. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

B. NC bypass contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

E. Supplemental Digital Meters:

1. Elapsed-time meter.
Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250,Type 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

F. Cooling Fan and Exhaust System: For NEMA 250, Type 1; UL 508 component recognized: Supply fan, with composite intake and exhaust grills and filters; 120 -V ac; obtained from integral CPT.

G. Control Power Ride-Through Capability: Provide constant voltage control power transformer or other means to ensure drive can withstand a minimum voltage dip/sag for up to 0.5 seconds. This includes all contactors, relays, etc.

H. Wiring Access Option: Coordinate with installer and select the correct wiring access panel option (i.e., top or bottom) for each VFD enclosure.

I. A Customer Interlock Terminal Strip – Provide a separate terminal strip for connection of fire, smoke, freeze contacts and external start command. All external interlocks and strat/stop contacts shall function with drive in hand, auto or bypass.

J. Output Line Reactors or Filters: Provide when the drive is separated from the motor by more than fifty (50) feet.

K. Door Interlock Circuit Breaker rated at 65,000 AIC with 5% total line impedance.

L. Thermal motor overcurrent relay.

2.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFDs according to requirements in NEMA ICS 61800-2

1. Test each VFD while connected to its specified motor.

2. Verification of Performance: Rate VFDs according to operation of functions and features specified.

B. VFDs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFDs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.

B. Examine VFD before installation. Reject VFDs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 HARMONIC ANALYSIS STUDY

A. Perform a harmonic analysis study to identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for VFD input filtering to limit TDD and THD (V) at each VFD at the defined PCC to specified levels.

B. Prepare a harmonic analysis study and report complying with IEEE 399 and NETA Acceptance Testing Specification.

3.3 INSTALLATION

A. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Wall-Mounting Controllers: Install VFDs on walls with tops at uniform height and with disconnect operating handles not higher than seventy nine (79) inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

C. Floor-Mounting Controllers: Install VFDs on four (4) inch nominal thickness concrete base.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses in each fusible-switch VFD.

F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

G. Comply with NECA 1.

3.4 IDENTIFICATION

A. Identify VFDs, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFD with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFDs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFD units.

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between VFDs and remote devices and the building automation system. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 FACTORY TESTS AND CHECKS

A. VFD power semiconductors and diodes shall be 100% inspected and tested, including load testing.

B. Small signal semiconductors, resistors, capacitors and diodes shall be lot sampled. Testing shall include parameter, as well as, functional characteristics.

C. All printed circuit-boards shall be tested under a temperature cycling (0^0C to $+65^0$C) 24-hour load test and then functionally tested via fault finder bench equipment prior to unit installation.

D. All final assemblies shall be tested at full load with application of line-to-line and line-to-ground bolted faults. The VFD shall trip electronically without device failure.

E. After all tests have been performed, each VFD shall undergo a twenty four (24) hour burn-in test. The drive shall be burned-in at 100% inductive or motor load for twenty four (24) hours without an unscheduled shutdown.

F. After the burn-in cycle is complete, each VFD shall be provided by the manufacturer upon request prior to shipment.

3.7 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 direct testing.

2. Testing, checkout and startup of the VFD equipment shall be performed under the technical direction of the manufacturer’s service engineer. Under no circumstances are any portions of the drive system to be energized without authorization from the manufacturer’s representative.

3. The contractor shall provide independent harmonic testing by an independent testing company. Readings with printouts of the harmonic current at each harmonic, as well as, the total voltage distortion. The following readings shall be provided:

a. At each point of common coupling:

1) With all drives running with load
2) With all drives off

b. At the power connection to each drive:

1) With the drive running loaded
2) With drive off

c. All the above data shall be submitted to the Owner for review. If these tests show the drives are not in compliance with the specifications, the drive manufacturer shall make all changes required to comply with the specifications at no cost to the Owner. If required, this could mean replacing the drives that are not in compliance.

d. A copy of all the tests and checks performed in the field, complete with meter readings and recordings, where applicable, shall be submitted to the Owner.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:

1. Inspect VFD, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFD locations are within 10% of motor nameplate rated voltages. If outside this range for any motor, notify Owner before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) 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 VFD. 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 VFD 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.

9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. VFD's will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies the VFD and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.8 STARTUP SERVICE

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

1. Complete installation and startup checks according to manufacturer's written instructions.
2. <Insert startup steps if any>.

3.9 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes or eleven (11) times for NEMA Premium Efficient motors if required. Where these maximum settings do not allow starting of a motor, notify Owner before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

F. Set field-adjustable pressure switches.

3.10 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFDs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

C. The VFD shall be protected against damage at all times. The drive shall be stored in a clean, dry environment with temperatures and humidity within the range specified by the drive manufacturer. Space heaters shall be energized controlled storage as recommended by the manufacturer. Storage space shall be environmentally controlled.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFDs.

END OF SECTION 262923

SECTION 263353 - STATIC UNINTERRUPTIBLE POWER SUPPLY

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. UPS systems.
2. Surge suppression.
3. Rectifier-charger.
4. Inverter.
5. Controls and indications.
6. Static bypass transfer switch.
7. Maintenance bypass/isolation switch.
8. Battery.
9. Basic battery monitoring.
10. Battery-cycle warranty monitoring.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GTO: Gate turn-off thyristor.

C. IGBT: Isolated gate bipolar transistor.

D. LCD: Liquid-crystal display.

E. LED: Light-emitting diode.

F. NiCd: Nickel cadmium.

G. PC: Personal computer.

H. SPD: Surge protection device.

I. THD: Total harmonic distortion.

J. UPS: Uninterruptible power supply.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of UPS.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for UPS.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For UPS.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
4. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Seismic Qualification Certificates: For UPS equipment, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Product Certificates: For each product, from manufacturer.

D. Factory Test Reports: Comply with specified requirements.

E. Product Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.

F. Field quality-control reports.

G. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For UPS units to include in emergency, operation, and maintenance manuals.

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. Fuses: One for every 10 of each type and rating, but no fewer than one set of each.
2. Cabinet Ventilation Filters: One complete set(s).

1.8 QUALITY ASSURANCE

A. Power Quality Specialist Qualifications: A registered professional electrical engineer or engineering technician, currently certified by the National Institute for Certification in Engineering Technologies, NICET Level 4, minimum, experienced in performance testing UPS installations and in performing power quality surveys similar to that required in "Performance Testing" Article.

B. Testing Agency Qualifications: Certified by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.9 WARRANTY

A. Special Battery Warranties: Manufacturer and Installer agree to repair or replace UPS system storage batteries that fail in materials or workmanship within specified warranty period.

1. Warranted Cycle Life for Valve-Regulated, Lead-Calcium Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of 77 deg F:
2. Warranted Cycle Life for Premium Valve-Regulated, Lead-Calcium Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of 77 deg F:

3. Warranted Cycle Life for Flooded Batteries: Equal to or greater than that represented in manufacturer's published table, but not less than the following, based on annual average battery temperature of 77 deg F:

B. Special UPS Warranties: Specified form in which manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within special warranty period.

1. Special Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OPERATIONAL REQUIREMENTS

A. Automatic operation includes the following:

1. Double Conversion, IGBT:

a. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output. High-efficiency carrier stored trench IGBT, in both rectifier-charger and inverter circuits, provides a minimum of 97 percent efficiency for the UPS system at full load and a minimum of 94 percent efficiency at 50 percent load.
b. Abnormal Supply Conditions: If normal supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to provide constant, regulated inverter power output to the load.
c. Power Failure: If normal power fails, the rectifier-charger and inverter use energy from the battery to supply constant, regulated power output to the load without switching or disturbance.

2. When power is restored at the normal supply terminals of the system, controls shall automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger shall supply power to the load through the inverter and simultaneously recharge the battery.
3. If the battery becomes discharged and normal supply is available, the rectifier-charger shall charge the battery. The rectifier-charger shall automatically shift to float-charge mode on reaching full charge.
4. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch shall switch the load to the normal ac supply circuit without disturbance or interruption.

5. The output power converters shall produce up to 300 percent of rated full-load current for short-circuit clearing. The inverter shall sustain steady-state overload conditions of up to 200 percent of rated full-load current for 60 seconds in normal operation.
6. The inverter shall be capable of sustaining 150 percent of system capacity for 30 seconds while powered from the battery.
7. Should overloads persist past the time limitations, the automatic static transfer switch shall switch the load to the bypass output of the UPS. When the fault has cleared, the static bypass transfer switch shall return the load to the UPS system.
8. If the battery is disconnected, the UPS shall supply power to the load from the normal supply with no degradation of its regulation of voltage and frequency of the output bus.

B. Manual operation includes the following:

1. Turning the inverter off causes the static bypass transfer switch to transfer the load directly to the normal ac supply circuit without disturbance or interruption.
2. Turning the inverter on causes the static bypass transfer switch to transfer the load to the inverter.

C. Maintenance Bypass/Isolation Switch Operation: Switch is interlocked so it cannot be operated unless the static bypass transfer switch is in the bypass mode. Device provides manual selection among the three conditions described below without interrupting supply to the load during switching:

1. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS ac input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.
2. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
3. Normal: Normal UPS ac supply terminals are energized and the load is supplied through the static bypass transfer switch and the UPS rectifier-charger and inverter, or the battery and the inverter.

D. Environmental Conditions: The UPS shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except battery performance:

1. Ambient Temperature for Electronic Components: 32 to 104 deg F.
2. Ambient Temperature for Battery: 41 to 95 deg F.
3. Relative Humidity: Zero to 95 percent, noncondensing.
4. Altitude: Sea level to 4000 feet.

2.2 PERFORMANCE REQUIREMENTS

A. UL Compliance: Listed and labeled by an NRTL to comply with UL 1778.

B. The UPS shall perform as specified in this article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a maximum load crest factor of 3.0, under the following conditions or combinations of the following conditions:

1. Inverter is switched to battery source.
2. Steady-state ac input voltage deviates up to plus or minus 10 percent from nominal voltage.
3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
4. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
5. Load is 100 percent unbalanced continuously.

C. Minimum Duration of Supply: If battery is sole energy source supplying rated full-load UPS current at 80 percent power factor, duration of supply is 15 minutes.

D. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state ac input voltage varies plus 10 percent and minus 20 percent from nominal voltage.

E. Overall UPS Efficiency: Equal to or greater than 95 percent at 100 percent load, 95 percent at 75 percent load, and 94 percent at 25 percent load.

F. Maximum Energizing Inrush Current: Soft start linear input current rise to 100 percent over a 1- to 40-second period, factory set at 10 seconds.

G. AC Output-Voltage Regulation for Loads 100 Percent Unbalanced: Maximum of plus or minus 2 percent over the full range of battery voltage.

H. AC Output-Voltage Regulation for Loads 100 Percent Balanced: Maximum of plus or minus 1 percent over the full range of battery voltage.

I. Output Frequency: 60 Hz, plus or minus 0.1 percent over the full range of input voltage, load, and battery voltage.

J. Limitation of harmonic distortion of input current to the UPS shall be as follows:

1. Description:

a. Rectifier-charger circuits shall limit THD to 5 percent, maximum, at rated full-load UPS current, for power sources with X/R ratio between 2 and 30. Provide tuned harmonic filter if required to meet harmonic distortion limit.
b. THD is limited to a maximum of 32 percent, at rated full-load UPS current, for power sources with X/R ratio between 2 and 30.

K. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent rms total and 3 percent rms for any single harmonic, for 100 percent rated nonlinear load current with a load crest factor of 3.0.

L. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of rated full load for 10 minutes, 200 percent for 60 seconds in normal operation, and 150 percent for 30 seconds in battery operating mode.

M. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage shall remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 50 ms:

1. 50 Percent: Plus or minus 3 percent.
2. 100 Percent: Plus or minus 5 percent.
3. Loss of AC Input Power: Plus or minus 1 percent.
4. Restoration of AC Input Power: Plus or minus 1 percent.

N. Input Power Factor: A minimum of 0.95 lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current without additional filters.

O. Output Power Factor Rating: Loads with power factor of 0.9 leading to 0.8 lagging shall not require derating of the UPS. For loads with power factors outside this range, derate the UPS output as follows:

1. Derate the UPS a maximum of 5 percent for 0.7 PF lagging.
2. Derate the UPS a maximum of 10 percent for 0.6 PF lagging.
3. Derate the UPS a maximum of 15 percent for 0.5 PF lagging.
4. Derate the UPS a maximum of 20 percent for a range of 0.4 to 0.1 PF lagging.

P. EMI Emissions: Comply with FCC rules and regulations and with 47 CFR 15 for Class A equipment.

2.3 UPS SYSTEMS

A. Description: Self-contained, battery backup device and accessories that provides three-phase electrical power in the event of failure or sag in the normal power system.

B. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.

C. Enclosures: Comply with NEMA 250, Type 1, unless otherwise indicated.

D. Configuration: Single-cabinet

E. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.

F. Maintainability Features: Mount rectifier-charger and inverter sections and the static bypass transfer switch on modular plug-ins, readily accessible for maintenance.

G. 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.

H. Capacity Upgrade Capability: Arrange wiring, controls, and modular component plug-in provisions to permit future 25 percent increase in UPS capacity.

I. UPS Cabinet Ventilation: Redundant fans or blowers draw in ambient air near the bottom of cabinet and discharge it near the top rear.

J. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity: Rated phase current times a multiple of 1.73, minimum.

2.4 SURGE SUPPRESSION

A. Protect internal UPS components from surges that enter at each ac power input connection including main disconnect switch, static bypass transfer switch, and maintenance bypass/isolation switch. Protect rectifier-charger, inverter, controls, and output components.

1. Use factory-installed surge suppressors tested according to IEEE C62.41.1 and IEEE C62.41.2, Category B.

2.5 RECTIFIER-CHARGER

A. Description: Voltage source converter, 12-pulse IGBT rectifier.

B. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.

C. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.

D. Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.

1. Response Time: Field adjustable for maximum compatibility with local generator-set power source.

E. Battery Float-Charging Conditions: Comply with battery manufacturer's written instructions for battery terminal voltage and charging current required for maximum battery life. The battery charger shall be matched to the battery type supplied.

2.6 INVERTER

A. Description:

1. Pulse-width modulated, IGBT with sinusoidal output.
2. Include a bypass phase synchronization window adjustment to optimize compatibility with local engine-generator-set power source.

2.7 CONTROLS AND INDICATIONS

A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.

B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include audible signals and visual displays.

C. Indications: Plain-language messages on a digital LCD.

1. Quantitative indications shall include the following:

a. Input voltage, each phase, line to line.
b. Input current, each phase, line to line.
c. Bypass input voltage, each phase, line to line.
d. Bypass input frequency.
e. System output voltage, each phase, line to line.
f. System output current, each phase.
g. System output frequency.
h. DC bus voltage.
i. Battery current and direction (charge/discharge).
j. Elapsed time discharging battery.

2. Basic status condition indications shall include the following:

    a. Normal operation.
    b. Load-on bypass.
    c. Load-on battery.
    d. Inverter off.
    e. Alarm condition.

3. Alarm indications shall include the following:

    a. Bypass ac input overvoltage or undervoltage.
    b. Bypass ac input overfrequency or underfrequency.
    c. Bypass ac input and inverter out of synchronization.
    d. Bypass ac input wrong-phase rotation.
    e. Bypass ac input single-phase condition.
    f. Bypass ac input filter fuse blown.
    g. Internal frequency standard in use.
    h. Battery system alarm.
    i. Control power failure.
    j. Fan failure.
    k. UPS overload.
    l. Battery-charging control faulty.
    m. Input overvoltage or undervoltage.
    n. Input transformer overtemperature.
    o. Input circuit breaker tripped.
    p. Input wrong-phase rotation.
    q. Input single-phase condition.
    r. Approaching end of battery operation.
    s. Battery undervoltage shutdown.
    t. Maximum battery voltage.
    u. Inverter fuse blown.
    v. Inverter transformer overtemperature.
    w. Inverter overtemperature.
    x. Static bypass transfer switch overtemperature.
    y. Inverter power supply fault.
    z. Inverter transistors out of saturation.
    aa. Identification of faulty inverter section/leg.
    bb. Inverter output overvoltage or undervoltage.
    cc. UPS overload shutdown.
    dd. Inverter current sensor fault.
    ee. Inverter output contactor open.
    ff. Inverter current limit.

4. Controls shall include the following:

    a. Inverter on-off.

b. UPS start.
c. Battery test.
d. Alarm silence/reset.
e. Output-voltage adjustment.

D. Dry-form "C" contacts shall be available for remote indication of the following conditions:

1. UPS on battery.
2. UPS on-line.
3. UPS load-on bypass.
4. UPS in alarm condition.
5. UPS off (maintenance bypass closed).

E. Emergency Power off Switch: Capable of local operation and operation by means of activation by external dry contacts.

2.8 STATIC BYPASS TRANSFER SWITCH

A. Description: Solid-state switching device providing uninterrupted transfer with a contactor or electrically operated circuit breaker to automatically provide electrical isolation for the switch.

B. Switch Rating: Continuous duty at the rated full-load UPS current, minimum.

C. Input SPD: 160 kA.

2.9 MAINTENANCE BYPASS/ISOLATION SWITCH

A. Description: Manually operated switch or arrangement of switching devices with mechanically actuated contact mechanism arranged to route the flow of power to the load around the rectifier-charger, inverter, and static bypass transfer switch.

1. Switch shall be electrically and mechanically interlocked to prevent interrupting power to the load when switching to bypass mode.
2. Switch shall electrically isolate other UPS components to permit safe servicing.
3. Switch shall electrically isolate the rectifier-charger, inverter, and static bypass transfer switch from the load, but shall allow primary power to the UPS for testing.

B. Comply with NEMA PB 2 and UL 891.

C. Switch Rating: Continuous duty at rated full-load UPS current.

D. Mounting Provisions: Separate wall- or floor-mounted unit.

E. Key interlock with key that is released only when the rectifier-charger and inverter are bypassed by the static bypass transfer switch. Key shall be required to unlock maintenance bypass/isolation switch before switching from open (normal) position to closed position. Lock shall be designed specifically for mechanical and electrical component interlocking.

2.10 OUTPUT DISTRIBUTION

A. Panelboards: Comply with Section 262416 "Panelboards,"

2.11 BATTERY

A. Description:

1. Valve-regulated, premium, heavy-duty, recombinant, lead-calcium units, complete with battery disconnect switch and intercell connectors.

    a. Factory assembled in an isolated compartment of UPS cabinet.
    b. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.

2.12 BASIC BATTERY MONITORING

A. Description: Continuous, real-time capture of battery performance data.

B. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.

C. Battery compartment high-temperature detector initiates an alarm when smoke or a temperature greater than 167 deg F occurs within the compartment.

D. Battery compartment smoke/high-temperature detector initiates an alarm when smoke or a temperature greater than 167 deg F occurs within the compartment.

E. Annunciation of Alarms: At UPS control panel and remotely.

2.13 BATTERY-CYCLE WARRANTY MONITORING

A. Description: Electronic device, acceptable to battery manufacturer as a basis for warranty action, for monitoring of charge-discharge cycle history of batteries covered by cycle-life warranties.

B. Performance: Automatically measure and record each discharge event, classify it according to duration category and total discharges according to warranty criteria, and display remaining warranted battery life on front panel display.

C. Additional monitoring functions and features shall include the following:

1. Measuring and Recording: Total voltage at battery terminal. Initiate an alarm for excursions outside the proper float-voltage level.
2. Monitoring: Ambient temperature at battery; initiate an alarm if temperature deviates from normally acceptable range.
3. Keypad on Device Front Panel: Provide access to monitored data using front panel display.
4. Alarm Contacts: Arrange to initiate local alarm for battery discharge events, abnormal temperature, abnormal battery voltage or temperature.
5. Memory: Store recorded data in nonvolatile electronic memory.
6. Ethernet Port: Permits downloading of data to a PC.

2.14 SOURCE QUALITY CONTROL

A. Factory test complete UPS system before shipment. Use actual batteries that are part of final installation. Include the following:

1. Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2. Full-load test.
3. Transient-load response test.
4. Overload test.
5. Power failure test.

B. Observation of Test: Give 14 days' advance notice of tests and provide opportunity for Owner's representative to observe tests at Owner's choice.

C. Report test results. Include the following data:

1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
3. List of instruments and equipment used in factory tests.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for conditions affecting performance of the UPS.

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

C. Verify installation conditions are representative of the conditions used in the coordination studies for the electrical system. Provide fuse protection according to Section 262813 "Fuses" if required for coordination with UPS overcurrent protective device requirements.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install cables in raceways and cable trays except within consoles and cabinets. Conceal raceway and cables except in unfinished spaces.
   1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Equipment Mounting: Install UPS on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base 6 inches from the outer edge of the base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

E. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

F. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated. Apply oxide inhibitor on battery terminals.

3.3 GROUNDING

A. Separately Derived Systems:

1. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify each battery cell individually.

3.5 BATTERY EQUALIZATION

A. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.

3.6 FIELD QUALITY CONTROL

A. Administrant for Tests and Inspections:

1. Owner will engage qualified testing agency to administer and perform tests and inspections.
2. Engage qualified testing agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections with assistance of factory-authorized service representative].

B. Tests and Inspections:

1. Inspect interiors of enclosures, including the following:

a. Inspect anchorage, alignment, grounding, and required clearances.
b. Component type and labeling verification.
c. Ratings of installed components.

2. Test electrical and mechanical interlock systems for correct operation and sequencing.
3. Inspect bolted electrical connections for high resistance using one or more of the following methods:

    a. Use of low-resistance ohmmeter according to Section 7.22.2.2 of NETA ATS.
    b. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or Table 100.12 of NETA ATS.
    c. Perform thermographic survey according to Section 9 of NETA ATS.

4. Test static transfer from inverter to bypass and back. Use normal load, if possible.
5. Test dc undervoltage trip level on inverter input breaker. Set according to manufacturer's published data.
6. Verify synchronizing indicators for static switch and bypass switches.
7. Test insulated-case and molded-case breakers.

    a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 of NETA ATS.
    b. Perform insulation-resistance tests on all control wiring for 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, follow manufacturer's recommendation.
    c. Use primary current injection to determine long time and short time, ground fault, and instantaneous pickup, Use secondary current injection to test trip functions.
    d. Perform minimum pickup voltage tests on shunt trip and close coils according to manufacturer's published data.
    e. Verify operation of charging mechanism.
    f. Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, antipump function, and trip unit battery condition. Reset all trip logs and indicators.

8. Test automatic transfer switches.

    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable, according to Section 7.22.3.1 of NETA ATS.
    b. Perform insulation-resistance tests on all control wiring for 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 for control devices that cannot tolerate the applied voltage, follow manufacturer's recommendation.

c. Perform a contact/pole-resistance test.
d. Verify settings and operation of control devices.
e. Calibrate and set all relays and timers according to Section 7.9 of NETA ATS.
f. Verify phase rotation, phasing, and synchronized operation as required by the application.
g. Perform automatic transfer tests.

1) Simulate loss of normal power.
2) Return to normal power.
3) Simulate loss of emergency power.
4) Simulate all forms of single-phase conditions.

h. Verify correct operation and timing of the following functions:

1) Normal source voltage-sensing and frequency-sensing relays.
2) Time delay on transfer.
3) Alternative source voltage-sensing and frequency-sensing relays.
4) Automatic transfer operation.
5) Interlocks and limit switch function.
6) Time delay and retransfer on normal power restoration.

9. Test direct current system's batteries.

a. Verify adequacy of battery support racks, mounting, anchorage, alignment, grounding, and clearances.
b. Inspect spill containment installation. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended settings.
c. Verify all charger functions and alarms.
d. Measure each cell voltage and total battery voltage with charger energized and in float mode of operation.
e. Perform a load test according to manufacturer's published data or IEEE 450.
f. Measure charger float and equalizing voltage levels. Adjust to battery manufacturer's recommended settings.
g. Test values.

1) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2) Charger float and equalize voltage levels shall be according to battery manufacturer's published data.
3) The results of charger functions and alarms shall be according to manufacturer's published data.

4) Cell voltages shall be within 0.05 V of each other or according to manufacturer's published data.
5) Cell internal ohmic values (resistance, impedance, or conductance) shall not vary by more than 25 percent between identical cells that are in a fully charged state.
6) Results of load tests shall be according to manufacturer's published data or IEEE 450.

10. Test communication of status and alarms to remote monitoring equipment.
11. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated within the previous six months according to NIST standards.

a. Simulate malfunctions to verify protective device operation.
b. Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.
c. Test harmonic content of input and output current at 25, 50, and 100 percent of rated loads.
d. Test output voltage under specified transient-load conditions.
e. Test efficiency at 50, 75, and 100 percent of rated loads.
f. Test remote status and alarm panel functions.
g. Test battery-monitoring system functions.

C. The UPS system will be considered defective if it does not pass tests and inspections.

D. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

E. Prepare test and inspection reports.

3.7 PERFORMANCE TESTING

A. Engage the services of a qualified power quality specialist to perform tests and activities indicated for each UPS system.

B. Monitoring and Testing Schedule: Perform monitoring and testing in a single 10-day period

1. Schedule monitoring and testing activity with Owner, through Architect, with at least 14 days' advance notice.
2. Schedule monitoring and testing after Substantial Completion, when the UPS is supplying power to its intended load.

C. Monitoring and Testing Instruments: Three-phase, recording, power monitors. Instruments shall provide continuous simultaneous monitoring of electrical parameters

at UPS input terminals and at input terminals of loads served by the UPS. Instruments shall monitor, measure, and graph voltage current and frequency simultaneously and provide full-graphic recordings of the values of those parameters before and during power-line disturbances that cause the values to deviate from normal beyond the adjustable threshold values. Instruments shall be capable of recording either on paper or on magnetic media and have a minimum accuracy of plus or minus 2 percent for electrical parameters. Parameters to be monitored include the following:

1. Current: Each phase and neutral and grounding conductors.
2. Voltage: Phase to phase, phase to neutral, phase to ground, and neutral to ground.
3. Frequency transients.
4. Voltage swells and sags.
5. Voltage Impulses: Phase to phase, phase to neutral, phase to ground, and neutral to ground.
6. High-frequency noise.
7. Radio-frequency interference.
8. THD of the above currents and voltages.
9. Harmonic content of currents and voltages above.
10. Battery cell temperature during charging.
11. Ambient temperature.

D. Monitoring and Testing Procedures for Each Test Period:

1. Exploratory Period: For the first two days of the first scheduled monitoring and testing period, make recordings at various circuit locations and with various parameter-threshold and sampling-interval settings. Make these measurements with the objective of identifying optimum UPS, power system, load, and instrumentation setup conditions for subsequent test and monitoring operations.
2. Remainder of Test Period: Perform continuous monitoring of at least two circuit locations selected on the basis of data obtained during exploratory period.

    a. Set thresholds and sampling intervals for recording data at values selected to optimize data on performance of the UPS for values indicated, and to highlight the need to adjust, repair, or modify the UPS, distribution system, or load component that may influence its performance or that may require better power quality.
    b. Perform load and UPS power source switching and operate the UPS on generator power during portions of test period according to directions of Owner's power quality specialist.
    c. Operate the UPS and its loads in each mode of operation permitted by UPS controls and by the power distribution system design.
    d. Using loads and devices available as part of the facility's installed systems and equipment and a temporarily connected portable generator set, create and simulate unusual operating conditions, including outages, voltage swells and sags, and voltage, current, and frequency transients. Maintain

normal operating loads in operation on system to maximum extent possible during tests.

e. Using temporarily connected resistive/inductive load banks and a temporarily connected portable generator set, create and simulate unusual operating conditions, including outages, voltage swells and sags, and voltage, current, and frequency transients. Maintain normal operating loads in operation on system to maximum extent possible during tests.

f. Make adjustments and repairs to UPS, distribution, and load equipment to correct deficiencies disclosed by monitoring and testing; repeat appropriate monitoring and testing to verify success of corrective action.

E. Coordination with Specified UPS Monitoring Functions: Obtain printouts of built-in monitoring functions specified for the UPS and its components in this Section that are simultaneously recorded with portable instruments in this article.

1. Provide the temporary use of an appropriate PC and printer equipped with required connections and software for recording and printing if such units are not available on-site.
2. Coordinate printouts with recordings for monitoring performed according to this article, and resolve and report any anomalies in and discrepancies between the two sets of records.

F. Monitoring and Testing Assistance by Contractor:

1. Open UPS and electrical distribution and load equipment and wiring enclosures to make monitoring and testing points accessible for temporary monitoring probe and sensor placement and removal as requested.
2. Observe monitoring and testing operations; ensure that UPS and distribution and load equipment warranties are not compromised.
3. Perform switching and control of various UPS units, electrical distribution systems, and load components as directed by power quality specialist. Specialist shall design this portion of monitoring and testing operations to expose the UPS to various operating environments, conditions, and events while response is observed, electrical parameters are monitored, and system and equipment deficiencies are identified.
4. Make repairs and adjustments to the UPS and to electrical distribution system and load components, and retest and repeat monitoring as needed to verify validity of results and correction of deficiencies.
5. Engage the services of the UPS manufacturer's factory-authorized service representative periodically during performance testing operations for repairs, adjustments, and consultations.

G. Documentation: Record test point and sensor locations, instrument settings, and circuit and load conditions for each monitoring summary and power disturbance recording. Coordinate simultaneous recordings made on UPS input and load circuits.

H. Analysis of Recorded Data and Report: Review and analyze test observations and recorded data and submit a detailed written report. Include the following in each report:

1. Descriptions of corrective actions performed during monitoring and survey work and their results.
2. Recommendations for further action to provide optimum performance by the UPS and appropriate power quality for non-UPS loads. Include a statement of priority ranking and a cost estimate for each recommendation that involves system or equipment revisions.
3. Copies of monitoring summary graphics and graphics illustrating harmonic content of significant voltages and currents.
4. Copies of graphics of power disturbance recordings that illustrate findings, conclusions, and recommendations.
5. Recommendations for operating, adjusting, or revising UPS controls.
6. Recommendations for alterations to the UPS installation.
7. Recommendations for adjusting or revising generator-set or automatic transfer switch installations or their controls.
8. Recommendations for power distribution system revisions.
9. Recommendations for adjusting or revising electrical loads, their connections, or controls.

I. Interim and Final Reports: Provide an interim report at the end of each test period and a final comprehensive report at the end of final test and analysis period.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train. Owner's maintenance personnel to adjust, operate, and maintain the UPS.

END OF SECTION 263353

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/modules, and drivers.
2. Exit signs.
3. Lighting fixture supports.

1.4 DEFINITIONS

A. BF: Ballast factor.

B. CCT: Correlated color temperature.

C. CRI: Color-rendering index.

D. LER: Luminaire efficacy rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting fixture, including lamp module/driver 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. Lamps/Modules
3. Drivers
4. Energy-efficiency data.

5. 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. Installation instructions.

C. Product Certificates: For each type of driver and dimmer-controlled fixtures, from manufacturer.

D. Field quality-control reports.

E. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp/module types used on Project; use ANSI and manufacturers' codes.

F. 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. LED fixtures shall comply with the following:

1. UL Standard 8750 “Light Emitting Diode Equipment for Use in Lighting Products”.

2. IES Standard LM-79 “Electrical and Photometric Measurements of Solid-State Lighting Products”.

3. IES Standard LM-80 “Measuring Lumen Maintenance of LED Light Sources”.

4. IES Standard TM-21 “Projecting Long term Lumen Maintenance of LED Light Sources”.

5. ANSI C78.377 “Specifications for the Chromaticity of Solid State Lighting Products” with LEDs binned within a maximum three-step MacAdam Ellipse to ensure color consistency amongst luminaires of the same type.

E. 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. 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.

2. LED Lamps/Modules: One (1) for every one hundred (100) of each type and rating installed. Furnish at least one (1) of each type.

3. LED Drivers: One (1) for every one hundred (100) of each type and rating installed. Furnish at least one (1) of each type.

4. 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.

C. Warranty Period: Modules (lamps), drivers and all components, provide a complete warranty for parts and labor for a minimum of five (5) years from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

D. Diffusers and Globes:

1. Acrylic Lighting Diffusers: 100 % virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

    a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
    b. UV stabilized.

E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp and ballast characteristics:

    a. "USE ONLY" and include specific lamp type.
    b. Lamp/Module code configuration type, and nominal wattage for luminaires.

c. Driver type (dim, non-dim, etc.) for luminaires.
d. CCT and CRI for all luminaires.

F. LED lighting fixtures scheduled on the drawings are found to offer products similar to the basis of design product, including performance, appearance, and quality. Listed equals must comply with minimum performance criteria. Additional documentation and calculations for LED lighting fixtures compliance should be made available upon request.

2.3 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for, visibility, luminance, and lettering size, comply with authorities having jurisdiction. Provide RED color sign.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

2.4 LED Lighting Products:

A. Acceptable Manufacturers:

1. Luminaires:
   a. Refer to the Luminaires Schedule on the drawings.

2. Drivers:
   a. Cree.
   b. EldoLED.
   c. Philips/Advance.
   d. Thomas Research Products.
   e. Or as supplied by the luminaire manufacturer, in compliance with these Specifications.

3. Dimmable Drivers:
   a. Cree.
   b. EldoLED.
   c. Philips/Advance.
   d. Thomas Research Products.
   e. Or as supplied by the luminaire manufacturer, in compliance with these Specifications.

B. Luminaires:

1. Refer to Luminaire Schedule for specified parameters such as correlated color temperature (CCT) value(s), lumen output, efficiency, etc.
2. Products shall be fabricated to be Reduction of Hazardous Substances (RoHS) - compliant.

3. Must maintain their warrantied life while operating within the manufacturers' specified environmental parameters.
4. The lumen value specification listed in the Luminaire Schedule is a delivered lumen value specification. Products supplied shall deliver not less than the lumen value specified.
5. The lumen maintenance specification of any assembled LED based chip, array, module, driver, and luminaire combination shall be a minimum of L70, at 50,000 hours, as tested and measured in compliance with IES documents LM-79 and LM-80.
6. Except as otherwise stated in the Luminaire Schedule, the light source shall provide a minimum CRI of 80.

C. Drivers: Listed and so labeled per UL 8750 and UL 1310, and shall meet or exceed the following general specification criteria:

1. Designed and tested to be compatible with the luminaire light source operating current, voltage, and output power requirements.
2. Inaudible above 27 dBA ambient sound level.
3. Designed, fabricated, and tested to operate at an input voltage of 120 – 277VAC, ±10% at 60 Hz, with no perceptible change in light source output.
4. Contribute less than 20% total harmonic distortion, operating at full rated load, and shall not exceed the maximum allowable THD requirements allowed per standard ANSI C82.11.
5. Provided with integral short circuit, open circuit, and overload protection.
6. Have an operating power factor ≥ 0.9.
7. Limit conducted and radiated interference in compliance with FCC 47 CFR Part 15.
8. Housed in a UL compliant and listed enclosure, suitable for remote installation where required, and listed for installation within spaces used for environmental air (plenum), as defined in NFPA 70 – the National Electrical Code.

D. Dimmable Drivers - In addition to the general specification criteria specified above:

1. Have an operating power factor of ≥ 0.9 at full load, and not less than 0.8 at dimmed level.
2. Provide smooth, flicker-free, dimmable light output from 100% to less than 1%.
3. 0-10VDC "sinking" type dimming control protocol per enforced version of IEC Standard 60929, unless otherwise noted or required.

2.5 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. Rod Hangers: Three sixteenth (3/16) inch minimum diameter, cadmium-plated, threaded steel rod.

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. 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.

END OF SECTION 265100

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. Extend the existing to remain fire alarm systems with to accommodate renovation spaces and supervise new pre-action system.
2. Contractor shall provide and install micro-processor based fire alarm and detection system devices in accordance with NFPA 72. The system components shall be the product of Notifier. Installation shall include all parts, labor, software, and hardware necessary to effect a complete installation.

B. Section Includes:

1. Fire-alarm control unit (Existing to Remain).
2. Notification appliances.
3. Addressable interface device.
4. Control relays and contact input modules.

1.3 EXISTING TO REMAIN 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. System shall be capable of full monitoring, control and remote control through UMB Campus Central Network Stations. System to have voice audible capability and shall be connected to UMB Mass Notification System.

D. Mass Notification System (MNS) shall be designed and installed per NFPA 72. System shall meet the requirements of one-way emergency communications systems with in-building MNS capabilities.

E. Presently, UMB has a contract to upgrade the existing buildings FACP and Network Command Centers (NCC's) with the latest version of Software/Firmware. Under this project, the contractor shall coordinate with the UMB Project Manager for the programming of the building panel and the correct version of Software/Firmware must be provided prior to programming.

F. UMB does not have a service contract with any other company to work on the existing fire alarm system. Any certified Notifier Fire Alarm System distributor can work on the system. Upon request the contractor shall provide proof of their Notifier Engineered System Distributor Agreement to the University.

G. General:

1. The existing fire alarm control panel for the building 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. UMB does not monitor networks at the buildings.
2. Each day, the contractor and sub-contractors shall sign-in and sign-out the fire alarm system at the Campus Police Station located at Pine St. Annex, 222 N Pine St, Baltimore, MD.

H. Prior to starting of work, the contractor will test the existing building fire alarm system to identify any deficiencies:

I. Prior to programming the fire alarm system at all buildings, the contractor shall contact UMB Project Manager to obtain available nodes.

J. Prior to programming of the new/existing FACP, the contractor shall verify in field exact room numbers and names for all initiating devices, elevator numbers and stair numbers to program the correct device address.

K. Initiating Devices: Provide initiating devices for each application throughout as required by NFPA 72.

L. Provide interface connections for all elevator functions. If the buildings have multiple elevator controllers, provide monitor modules for each elevator.

M. 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 any additional notification appliances as required by the ADA.
3. Fire alarm notification appliances shall remain active until the fire alarm system is manually silenced or acknowledged.
4. Both audible and visible notification appliances shall be simultaneously de-activated.

N. 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.

O. There are four (4) Network Command Centers (NCC) installed on the campus. Provide all new work associated with the connections, programming and modifications to the existing NCC's under this project.

1.4 SUBMITTALS

A. General Submittal Requirements: Comply with the UMB General Conditions.

1. Prior to submission to UMB Fire Marshal, submittal must be reviewed by the Engineer of Record.
2. Shop Drawings shall be prepared by persons trained and certified by the manufacturer in fire-alarm system design. Shop drawings shall be signed or stamped by an individual with one of the following qualifications:

    a. NICET fire-alarm technician, Level IV minimum.
    b. The qualified individual signing the shop drawings must attend any and all review comment resolution meetings requested by the University.

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 NFPA 72 "Documentation" chapter.
2. Include voltage drop calculations for notification appliance circuits.
3. Include battery-size calculations.
4. Load Calculations - Provide load calculations for all NAC circuits while noting both current demand and future capacity in amperes.
5. Device Address List: Coordinate with final system programming. Floor plans shall include address numbers for all devices.

6. 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.
7. Details of graphic and alphanumeric annunciators.
8. Include List of extra materials to be provided for the project.
9. Provide one (1) printed set of drawings ("full-size" twenty (24) inches x thirty (36) inches) and one (1) electronic file in pdf file format.
10. Shop Drawings must include the following:

    a. Provide floor plans with ALL device locations and their associated addresses. Floor plans must be drawn to scale. Provide graphic scales on the drawings.
    b. For new building construction projects or replacement of existing building entire fire alarm system projects, use NFPA 170 symbols.
    c. For renovation projects match the symbols used on As-Builts.
    d. Provide a riser diagram, regardless of system size.
    e. 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.

11. 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.

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.

G. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

H. Informational Submittals: Submit the 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.

I. Submissions to UMB Fire Marshal:
1. 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.

J. Project Closeout Submittals: Submit the following in accordance with the UMB General Conditions.

1. Electronic Copies of System Program: Provide a minimum of two (2) electronic copies of the system program on USB Flash Drive. Store one (1) USB Flash Drive copy of the program at the FACP and hand the other copy over to the

Project Manager. Besides being required by NFPA 72, the purpose for this requirement is to ensure the owner always has on hand a "bug free" copy of the original.

2. Manufacturer's As-Built Drawings: Submit one (1) set of the Manufacturer's As-Built Drawings as a hard copy to UMB Fire Marshal for review prior to scheduling a Final Acceptance Test.

   a. As-Built Drawings: The FAS Manufacturer shall revise/update the FAS Shop Drawings to accurately reflect the following field installation data/conditions:

      1) All individual device addresses on the floor plans.
      2) Conduit/SLC & NAC Loop Wiring Layout - Show routing of all FAS wiring and raceway including riser runs and while noting all FAS device and panel locations. Identify all panels with their respective ID numbers/lettering as entered in the FAS programming software. Where multiple FAS circuits are run in parallel and/or grouped together, attach drawing notes to the runs to identify the individual FAS circuits in the grouped or parallel run. Delineate overhead versus underground runs by using dashed lines for underground.
      3) Riser and/or connection diagram.

   b. Equipment Data: Provide Manufacturer's catalog information on all internal network cards/option modules in the system.
   c. Provide both paper and electronic (both AutoCAD 2010 and PDF format) copies. Provide three (3) paper copies in "half-size" sets and two (2) paper copies at full size.

3. Updated copies of load calculations, System Program and Sequence of Operation as submitted during in the shop drawing phase.
4. Maintenance Data: For fire alarm systems. Comply with NFPA 72.
5. Record of Completion: Comply with NFPA 72.

1.5 QUALITY ASSURANCE

A. The contractor shall have (or contractually be supported by a company who has) on staff and assigned to the project a NICET Level IV certified person for fire alarm systems.

B. A NICET Level II or higher Fire Alarm Technician or a Fire Alarm Technician with minimum of two (2) years' experience shall install and terminate fire alarm devices, cabinets and panels. The Fire Alarm technicians installing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings

C. An electrician or NICET Level II Fire Alarm Technician shall install conduit for the fire alarm system.

D. 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.

E. Manufacturer Qualifications: Firm experienced in manufacturing systems similar to those indicated for this Project and with record of successful in-service performance.

F. Source Limitations: Obtain fire alarm system components through one source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.

G. Compliance with Local Requirements: Comply with applicable building code, local ordinances and regulations, and requirements of UMB Fire Marshal.

H. Comply with NFPA 70 and 72.

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.

1.6 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:

1. Notify UMB Project Manager no fewer than ten (10) days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with fire-alarm outage without UMB Project Manager's written permission.
3. Where a required existing fire protection system is out of service or during system Outage, the contractor shall provide fire watch as required by the UMB Fire Mashal until the existing system is restored.
   http://www.umaryland.edu/media/umb/af/ehs/firesafety/FireWatchProcedures.pdf

1.7 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring as directed by UMB Project Manager and

UMB Fire Marshal. Existing equipment shall be removed immediately after new equipment is accepted.

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. Deliver materials to UMB Project Manager with Bill of Materials in accordance with UMB general conditions. **Include list of extra materials with the shop drawing submittal.** Where multiple buildings are being bid as one project, provide extra materials for each building.

1. Keys: One (1) extra set for access to locked and tamper proofed components.
2. FMM-1, FDM-1, FRM-1, FCM-1, FMM-101 addressable modules. Provide quantity equal to 20% of amount installed, but not less than two (2) units.

1.9 WARRANTY/GUARENTEE

A. See Division 26, Specification Section “Basic Electrical Requirements” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. Existing Fire Alarm System NOTIFIER**:**

a. Fire Alarm Control Panel Model NFS2-3030 with display.
b. Digital Voice Command (DVC), Voice Evacuation Control System.

2. 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 UMB Fire Marshal.
j. Provide all new wiring.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one (1) or more of the following devices and systems. *Existing Sequence of Operations shall be maintained*:

1. Manual stations.
2. Heat detectors.
3. Flame detectors.
4. Smoke detectors.
5. Elevator Machine Room initiating devices.
6. Verified automatic alarm operation of smoke detectors.
7. Automatic sprinkler system water flow.
8. Fire-extinguishing system operation.
9. Fire standpipe system.
10. Fire Pump Running

B. Supervisory signal initiation shall be by one (1) or more of the following devices and actions:

1. Valve supervisory switch.
2. Low-air-pressure switch of a dry-pipe sprinkler system.
3. Elevator shunt-trip supervision.
4. Beam detectors.
5. Halon system.
6. Duct smoke detectors.

C. System trouble signal initiation shall be by one (1) or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.
9. Fire-pump power failure, including a dead-phase or phase-reversal condition.
10. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.

D. System Trouble and Supervisory Signal Actions: Initiate and annunciate at fire-alarm control unit and remote annunciators. Record the event on system printer. Transmit trouble and supervisory signals to remote alarm receiving central network stations.

E. Control of System: By FACP and by Remote Transponder(s) as required on Contract Drawings.

F. System Supervision: Automatically detect and report open circuits, shorts, and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.

G. Priority of Signals: Automatic alarm response functions resulting from alarm signal from one zone or device are not altered by subsequent alarm, supervisory, or trouble signals. Alarm signal is highest priority. Supervisory and trouble signals have second- and third-level priority. Higher-priority signals take precedence over signals of lower priority, even when lower-priority condition occurs first. Annunciate and display all alarm, supervisory, and trouble signals regardless of priority or order received. If a live mass notification message is sent from the Campus Police, the broadcasted message shall have priority over the recorded building voice message.

H. Noninterference: Signal on one zone shall not prevent receipt of signals from other zones.

I. System Reset: All zones are manually resettable from FACP after initiating devices are restored to normal.

J. Transmission to Remote Alarm Receiving Station (Back-up Dialer): Provide Addressable Relay Modules (FRM-1) and a Digital Alarm Communication Transmitter (DACT) by the Fire Alarm Control panel as indicated. Arrange and program the DACT to route "alarm signals" only to the Campus Police back-up dialer.

K. Transmission to Remote Alarm Receiving Central Network Station: Provide all network programming for identification of devices at the existing fire alarm control panel and at the Central Network Station located at the Campus Police, UMB Fire Marshal’s Office, and Pearl Street Garage Electronics Shop.

L. Provide all network programming on node assigned to each building on the network system.

M. Loss of primary power at FACP initiates trouble signal at FACP and Graphic Annunciator Panel (GAP). Both FACP and GAP shall indicate when fire alarm system is operating on secondary power supply.

N. Basic Alarm Performance Requirements: Unless otherwise indicated, fire alarm signal activation shall initiate the following:

1. Notification-appliance operation:

a. General Alarm – All notification appliances in the building shall activate upon any alarm signals.
b. Voice Message - All floors. Recorded (FEMALE VOICE) message, shall be played throughout the building. The message shall be:

"MAY I HAVE YOUR ATTENTION PLEASE, MAY I HAVE YOUR ATTENTION PLEASE. AN EMERGENCY HAS BEEN REPORTED IN THE BUILDING. PLEASE LEAVE THE BUILDING BY THE NEAREST MARKED EXIT OR EXIT STAIRWELL. EXIT DIRECTLY TO THE OUTSIDE OF THE BUILDING FROM THE STAIRWELL. DO NOT REENTER THE BUILDING. DO NOT USE THE ELEVATORS."

Final wording of the above message must be submitted with the shop drawings for review and approval.

c. Provide the following recorded (FEMALE VOICE) Testing Message, programmed at the control panel:

"MAY I HAVE YOUR ATTENTION PLEASE, MAY I HAVE YOUR ATTENTION PLEASE. WE ARE CONDUCTING A TEST OF THE FIRE ALARM SYSTEM IN THE BUILDING. DISREGARD ANY EVACUATION ANNOUNCEMENTS YOU MAY HEAR. IF AN ACTUAL EMERGENCY OCCURS YOU WILL BE NOTIFIED." This message shall repeat for 4 times.

d. Provide the following recorded (FEMALE VOICE) Test Completed Message programmed at the control panel:

"MAY I HAVE YOUR ATTENTION PLEASE, MAY I HAVE YOU ATTENTION PLEASE. WE HAVE COMPLETED THE FIRE ALARM TESTING IN THE BUILDING. ANY EVACUATION NOTIFICATION AFTER THIS ANNOUNCEMENT IS FOR REAL. THANK YOU FOR YOUR COOPERATION." This message shall repeat for 4 times.

e. Provide the following recorded (FEMALE VOICE) Maintenance Message programmed at the control panel:

MAY I HAVE YOUR ATTENTION PLEASE, MAY I HAVE YOUR ATTENTION PLEASE. WE ARE PERFORMING MAINTENANCE ON THE FIRE ALARM SYSTEM IN THE BUILDING. DISREGARD ANY EVACUATION ANNOUNCEMENTS YOU MAY HEAR. IF AN ACTUAL EMERGENCY OCCURS YOU WILL BE NOTIFIED." This message shall repeat for 4 times.

f. Provide the following recorded (FEMALE VOICE) Maintenance Completed Message programmed at the control panel:

"MAY I HAVE YOUR ATTENTION PLEASE, MAY I HAVE YOU ATTENTION PLEASE. WE HAVE COMPLETED FIRE ALARM SYSTEM MAINTENANCE IN THE BUILDING. ANY EVACUATION NOTIFICATION AFTER THIS ANNOUNCEMENT IS FOR REAL. THANK YOU FOR YOUR COOPERATION." This message shall repeat for four (4) times.

2. Identify alarm at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock all electrical door locks unless directed otherwise by UMB Project Manager.
5. Release fire and smoke doors held open by magnetic door holders.
6. Activate voice/alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
8. Activate smoke-control system (smoke management) at firefighter smoke-control system panel.
9. Activate stairwell and elevator-shaft pressurization systems.
10. Close smoke dampers in air ducts of designated air-conditioning duct systems.
11. Recall elevators to primary or alternate recall floors.
12. Record events in the system memory.
13. Record events by the system printer.
14. Mass Notification Broadcast: In the event of an emergency, if a mass notification message is sent from the Campus Police, the broadcast message shall override the building recorded voice message.
15. The buildings BAS will coordinate the shutdown of an HVAC System and its' associated smoke and fire dampers due to a duct smoke detector activation from the FAS. **Do not perform any direct interconnection between the duct smoke detectors contact outputs and the HVAC System starter(s) and any of its' smoke and fire dampers. Provide a dedicated addressable relay for interface connections.**

O. Alarm Silencing, System Reset and Indication: Controlled by switches in FACP.

1. Silencing-switch operation halts alarm operation of notification appliances and activates alarm silence light. Display of identity of alarm zone or device is retained.
2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.

P. Remote Detector Sensitivity Adjustment: Manipulation of controls at FACP causes selection of addressable smoke detectors for adjustment, display of their current status and sensitivity settings, and control of changes from primary to alternate sensitivity setting. Sensitivity adjustment will be recorded in system memory and printed out by system printer. FAS shall automatically perform sensitivity test at no more than one month intervals.

Q. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble), and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate printout of list of historical log of events.

R. FACP and Remote Alphanumeric Displays: Plain-English-language descriptions of alarm, supervisory, and trouble events; and addresses and locations of alarm-initiating or supervisory devices originating report. Display monitoring actions, system and component status, system commands, programming information, and data from system's historical memory.

2.3 FIRE-ALARM CONTROL UNIT (EXISTING TO REMAIN)

A. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.

    a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
    b. Include a real-time clock for time annotation of events on the event recorder and printer.

2. Addressable initiation devices that communicate device identity and status.

    a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
    b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
1. Annunciator and Display: Liquid-crystal type, NFS2-3030 2 line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
3. Password: Contractor shall not change FACU password without written approval from UMB Electronics Shop and UMB Fire Marshal.

C. Circuits:

1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class B, with isolator modules to isolate each floor. Provide 20% spare capacity on each signaling line circuit.

2. Serial Interfaces: Two RS-232 ports for printers.

D. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

E. Notification Appliance Circuit: Operation shall start with a temporal pattern followed by the recorded voice message and continue alternating between the two.

F. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals, supervisory and digital alarm communicator transmitters, and digital alarm radio transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

G. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed, valve-regulated, recombinant lead acid.

H. Instructions: Provide manufacturers printed instructions inside FACU cabinet door.

I. 'Trouble,' 'Supervisory,' and 'Alarm' Contact Outputs to the UMB Central Monitoring Station and Autodialing Systems:

1. Provide six (6) 'FRM-1' relays for remotely reporting 'Trouble,' 'Supervisory,' and 'Alarm' contact outputs to the UMB Network Stations. Only ‘Alarm’ shall report to the Backup dialer System.
2. Mount the six (6) 'FRM-1' relays next to the FACP and put them on the local SLC that serves the floor the FACP is located on.

3. This requirement applies regardless of whether the Fire Alarm Control Panel has some amount of these outputs built into its' circuit boards. Do not use non-addressable, current relays to multiply these built-in outputs for this purpose.

J. UMB Custom Control Switches for FACP: Provide the following custom controls and switches integral to the FACP:

1. Provide an "All Evac." control switch that activates notification appliances on all floors while executing all life safety relays to recall the building elevators, notify the campus police via the remote reporting system, dropping out door holders, and starting any Life Safety HVAC systems (e.g. Stairwell Pressurization Fans, Atrium Exhaust System, etc.).
2. Provide an auto-disable control switch to disable all notification appliances in order to avoid disturbing building occupants during maintenance and/or repair work on the system.
3. Provide an auto-disable control switch to disable all elevator recall.
4. Provide an auto-disable control switch to disable all HVAC systems impacted by activation of the fire alarm system.
5. Provide an auto-disable control switch to disable all automatic door unlocks and all door hold-open magnets.
6. Provide an auto-disable control switch to disable all fire shutters.

K. Self-testing:

1. The FACP shall perform a test at least weekly to check the internal diagnostics of all connected devices. Test shall verify that all detector internal sensitivity levels are within range and if not, then issue a trouble/supervisory signal.

L. The audio amplifiers will provide audio power (@70 Volts RMS) for distribution to speaker circuits. Multiple audio amplifiers may be mounted in a single enclosure, either to supply incremental audio power, or to function as an automatically switched backup amplifier. The audio amplifier shall include an integral power supply and shall provide built-in LED indicators. All the controls shall be built-in to the audio amplifier. System shall be capable of backing up digital amplifiers. Provide model DAA2 series amp.

M. Standby (backup) Audio Amplifiers shall be provided that automatically sense the failure of a primary amplifier, and automatically program themselves to select and de-multiplex the same audio information channel of the failed primary amplifier, and fully replace the function of the failed amplifier. Provide model BDA-70 series amp.

N. Audio Message Generator (Prerecorded Voice)/Speaker Control:

1. Each initiating zone or intelligent device shall interface with an emergency voice communication system capable of transmitting a prerecorded voice message to all speakers in the building.

2. Actuation of any alarm initiating device shall cause a prerecorded message to sound over the speakers. The message shall be repeated four (4) times. Pre- and post-message tones shall be supported.
3. A built-in microphone shall be provided to allow paging through speaker circuits.
4. System paging from emergency telephone circuits shall be supported.
5. The audio message generator shall have the indicators and controls to allow for proper operator understanding and control.

O. Digital Voice Command Center:

1. The Digital Voice Command Center located with the FACP, shall contain all equipment required for all audio control, emergency telephone system control, signaling and supervisory functions. This shall include speaker zone indication and control, telephone circuit indication and control, digital voice units, microphone and main telephone handset.
2. Function: The Voice Command Center equipment shall perform the following functions:

    a. Operate as a supervised multi-channel emergency voice communication system.
    b. Operate as a two-way emergency telephone system control center.
    c. Audibly and visually annunciate the active or trouble condition of every speaker circuit and emergency telephone circuit.
    d. Audibly and visually annunciate any trouble condition for digital tone and voice units required for normal operation of the system.
    e. Provide all-call Emergency Paging activities through activation of a single control switch.
    f. As required, provide vectored paging control to specific audio zones via dedicated control switches.
    g. Provide a factory recorded "library" of voice messages and tones in standard WAV. File format, which may be edited and saved on a PC running a current Windows® operating system.
    h. Provide a software utility capable of off-line programming for the VCC operation and the audio message files. This utility shall support the creation of new programs as well as editing and saving existing program files. Uploading or downloading the VCC shall not inhibit the emergency operation of other nodes on the fire alarm network.
    i. Support an optional mode of operation with four analog audio outputs capable of being used with UL 864 fire-listed analog audio amplifiers and SCL controlled switching.
    j. The Digital Voice Command shall be modular in construction, and shall be capable of being field programmable without requiring the return of any components to the manufacturer and without requiring use of any external computers or other programming equipment.
    k. The Digital Voice Command and associated equipment shall be protected against unusually high voltage surges or line transients.

P. ACS Series Annunciators at Fire Alarm Control Panel for annunciation and control of Fire Alarm Control Panel. #ACM-XXAT.

2.4 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, and trumpet).

C. Beacon Lights:
   1. Provide rotating beacon lights in mechanical rooms or where indicated on the drawings. Edwards # 53DR-GW with WBR mounting bracket.

D. Speaker Notification Appliances (Industrial grade to match existing penthouse model):

   1. Speakers shall be provided for use with 70v system.
   2. High-Range Units: Rated 2 to 15 W.
   3. Low-Range Units: Rated 1 to 2 W.
   4. Mounting: Recessed wall or ceiling mounted are acceptable.
   5. Matching Transformers: Tap range matched to acoustical environment of speaker location.
      Provide Wheelock E50 Series.

E. Mount all notification appliances in manufacturer's optional red boxes.

2.5 GRAPHIC DISPLAY ANNUNCIATORS (EXISTING TO REMAIN/TO BE MODIFIED)

A. Description: Duplicate annunciator functions of FACP for alarm, supervisory, and trouble indications.

   1. Annunciator shall be modified to incorporate new pre-action system supervision and associated architectural revisions, if required.

   2. Mounting: Flush cabinet, NEMA 250, Class 1. See Contract Drawings for details. If space conditions does not allow for flush mounting, contractor shall coordinate with UMB project manager and get final approval for surface mounted cabinet.

B. Display Type and Functional Performance: Individual LED for each type of alarm and supervisory device, and LEDs to indicate normal power and trouble.

1. An alarm or supervisory signal causes illumination of floor light, device type light, and location.
2. System trouble causes illumination of all lights above and also trouble light.
3. Additional LEDs indicate normal power mode status for system.
4. A test switch tests LEDs mounted on panel. Switch does not require key operation. There shall be no audible signal associated with the testing of the LED's.
5. Graphics: Integrate LED displays with graphic display panel to form graphic annunciator.
6. Battery power on.

C. Graphic Display Annunciator: The Graphic Display Annunciator shall be provided with the following features and as directed by the UMB Fire Marshal.

1. Wall-mounted flush backlit panel indicating building floor plan with **"YOU ARE HERE"** designation in red text.
2. The building graphic shall have a white background and depict the building outline, stair locations (with stair labels), all elevators (with elevator labels), elevator machine rooms, location of the fire alarm control panel, location of fire pump (if any), a North arrow, and any other designations as required by the UMB Fire Marshal.
3. Provide an LED on the building graphic as follows:
   a. "RED" for Alarm/Normal Power failure, "YELLOW" for Supervisory and "GREEN" for Normal.
   b. An "LED" shall also be provided to identify floor, device type, and location.
   c. Pull Station – 'RED'.
   d. Smoke detector – "RED'.
   e. Heat detector – "RED".
   f. Water flow – 'RED'.
   g. Duct detector – 'YELLOW'.
   h. Tamper switch – "YELLOW".
   i. Fire Pump Running – "RED".
   j. Fire Pump Trouble – "YELLOW'.
   k. Fire Pump Normal - "GREEN".
   l. Halon System – "YELLOW".
   m. Beam detector – "YELLOW".

D. Materials: Anodized aluminum frame with graphics on white Plexiglas protected by non-glare Plexiglas.

E. Floor plan lines are to be black and all text shall be black one quarter (1/4) inch high minimum, except for "YOU ARE HERE," fire pump and FACP, which shall be red text.

F. Mounting: Integral with lamp-type annunciator.

G. Provide graphic annunciator as manufactured by QED or approved equal.

H. Trouble signal shall not light for the same event when a supervisory signal is illuminated.

I. Prior to fabrication of the Graphic Annunciator Panel the contractor shall submit final layout of the Graphic Annunciator Panel for approval by UMB Fire Marshal. Any errors or omissions on the graphic annunciator panel are the responsibility of the contractor at no additional cost to the owner.

J. Update existing Graphic Annunciator Panel as necessary for updated floor plans and/or changes to device locations (Re: New pre-action system).

K. On the Graphic Annunciator Panel provide building name and address.

L. Where multiple devices are located within the space, provide only one LED for that area and program for each device.

2.6 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

2.7 CONTROL RELAY AND CONTACT INPUT MODULES

A. Description: Units are equipped for wall mounting, complete with red enclosures.
   1. Wall-Mounted Units: Flush mounted, unless otherwise indicated.
   2. Rating: 120-VAC.
   3. Provide auxiliary control relays and required control power circuiting for all life safety relay functions (e.g. elevator recall, door holder release, electric door lock release, notifying the backup auto dialer system, etc.). Provide dedicated relays for each door holder installation (i.e. do not use current relays or use riser wiring), electric door lock location, and for alarm signals being reported to the auto dialer. Relays must be UL listed and compatible with the fire alarm system manufacturer's equipment.
   4. Provide a dedicated 'FDM-1' module for each set of Sprinkler System Flow Switch and Tamper switch locations. In other words, provide a dedicated addressable point/signal for each Flow Switch, Tamper Switch, etc. do not combine or parallel tamper and/or flow switches to a single fire alarm system relay input. This slows down UMB's ability to quickly locate the source of a constant alarm or trouble signal.
   5. Mount all relays in FAS manufacturer's red enclosures.

2.8 REMOTE POWER SUPPLY PANEL (IF REQUIRED)

A. Where required on the Contract Drawings, provide the following Remote Power Supplies Panel with battery charger:

1. Panel shall be Notifier Model #FCPS-24S8, as needed to provide sufficient power for notification circuits. Include batteries sized to provide twenty four (24) hour battery backup. Provide enclosure sized to support the above equipment.
2. In each FCPS, provide FM-101 monitoring module to individually monitor trouble at FACP.
3. FCPS (FABP) shown on the drawings is preliminary and reflect the design intent only. Contractor shall verify system power supply requirements and confirm quantity of power supplies needed.

2.9 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 MC FPLP

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.

2.10 TRANSIENT PROTECTION

A. Provide transient protection at the source panel for the following circuits at the specified locations that maybe vulnerable to voltage swells in the event of a lightning strike, ground swell or other phenomena. Although it may not entirely safeguard field wiring and/or devices, it will minimize the spread of loss to the more costly FAS Panel Circuit Boards.

B. 120VAC Power Circuits: Provide Silicone Surge Suppression for 120VAC to all control panel, transponder panel, graphic annunciator panels' and any other FAS power supplies. Mount surge suppressors at panel power supply terminals.

C. Low-Voltage, Shielded & Non-Shielded, Power-Limited Circuits: Provide Silicone Surge Suppression for the following low-voltage circuits that serve the following locations:

1. SLC & NAC (including speaker, voice audio, strobe, and horn): The top three (3) levels/floors; the bottom two (2) levels/floors; and all stairwells regardless of length of run in stairwell.
2. Phone & Network Phone: The top three (3) levels/floors; bottom two (2) levels/floors; and all stairwells regardless of length in stairwell.
3. FAS Backbone Network Loops: Protect ALL FAS Network and Network Data Circuits. The protected runs will include, but NOT be limited to, the following:

    a. FACP - Transponder; Transponder - Transponder; Transponder - FACP.
    b. GAP - FACP; FACP - remote printer; GAP - remote printer.
    c. GAP - Remote Annunciator; FACP - Remote Annunciator; Remote Annunciator - Transponder.

4. Low-Voltage Power Circuit Risers: All low-voltage power circuit risers located in and/or serving stairwell devices.

PART 3 - EXECUTION

3.1 SEQUENCE OF INSTALLATION (FOR AREA OF WORK FIRE ALARM REPLACEMENT PROJECTS)

A. Install horizontal cabling and appliances and devices in area of work.

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA and manufacturers installation instructions for installation of all fire-alarm equipment, devices and appliances.

B. Equipment Mounting: Install fire-alarm control unit on concrete base with tops of cabinets not more than seventy two (72) inches above the finished floor. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

C. 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.

D. Remote Status and Alarm Indicators: Install near each sprinkler water-flow switch and valve-tamper switch.

3.3 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Door Hardware section. Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than three (3) feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Supervisory connections at valve supervisory switches.
2. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.

C. 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.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Identification for Electrical Systems section.

B. SLC Loop Devices: Label all SLC loop devices to note the device address and purpose.

C. 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 #.

D. 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 ten (10) feet to fifteen (15) feet in concealed accessible areas (horizontal runs) and every twenty five (25) feet in exposed areas (horizontal runs) per UMB Standards. Wording for the FAS Raceway and Cabling shall be as follows:

1. FAS Backbone Network Loop: to read "FAS Vertical Network Loop – XX/0."
2. FAS Device Loop: to read "FAS Notification and Signal Appliance Loop XX Floor – XX/0."

E. 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.

F. 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."

3.5 WIRING INSTALLATION

A. Wiring Method:
1. Install wiring in metal raceway according to Raceways and Boxes section, unless otherwise directed on the contract drawings. Conceal raceway except in unfinished spaces and as indicated. DO NOT conceal fire alarm conduits in slabs.

B. Wiring Method:
1. Wiring Method: Provide all new wiring for the new fire alarm system. For exposed structure install wiring in EMT conduit. In concealed spaces provide plenum rated fire alarm cable. Plenum rated cables shall not be strapped, taped, or attached by any means to the exterior of any conduit, raceway, piping, ceiling grid or ductwork as means of support. Plenum cables shall be independently supported from the ceiling structure with J-hooks at four (4) feet intervals. For exposed structures outdoors and in parking garages install wiring in schedule 40 PVC conduits above six feet. For exposed and subject to severe physical damage, provide wiring in rigid steel conduit. Provide expansion joint fittings as required. Where existing conduits are being utilized, do not use existing in-slab conduits.

C. 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.

D. 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.

E. SLC and/or NAC 'T' Taps: 'T' taps are strictly prohibited on both SLC and NAC loops.

F. 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.

G. Risers: Install at least two vertical cable risers to serve fire alarm system. Separate risers in close proximity to each other with minimum one-hour-rated wall, so loss of one riser does not prevent receipt or transmission of signal from other floors or zones.

3.6 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE. 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 Grounding and Bonding section.

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.

3.7 FIELD QUALITY CONTROL

A. Final Acceptance test shall be witnessed by the UMB Fire Marshal.

B. Prior to testing of the system with the UMB Fire Marshal, the contractor shall conduct pre-testing of the system and correct all deficiencies.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

D. 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.

E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. 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. Provide documentation summarizing pretesting to UMB Fire Marshal. Documentation should include statement that system is working properly and

summary of corrections made during pretesting. Project Manager may attend contractor pretesting as desired.

I. The contractor shall have a fire alarm technician present during all tests and shall have laptop with them to modify and program changes during the tests.

J. Final acceptance testing with the UMB Fire Marshal: After installation, align, adjust, and balance system and perform complete testing with the UMB Fire Marshal.

K. Initial Test Notice: For new buildings, provide minimum of ten (10) days' notice in writing when system is ready for initial acceptance testing. For occupied/existing buildings, UMB Fire Marshal initial test must occur within 3 days of successful contractor pretest.

L. All testing will be verified at the main fire alarm control panel, at the building annunciator panel, and at the Campus Police Network Command Center. The contractor is responsible for providing all necessary personal to accomplish this testing at these three locations in addition to in the field.

M. The contractor shall switch over the fiber network connection to the new fire alarm control panel. The existing back-up dialer connected to the existing third party panel shall remain in operation. This switch over shall only be done on the day of or the day prior to the scheduled testing day.

N. Prior to the pretest, the contractor shall switch over the connections to the new modules for door holders, elevator controllers and any other auxiliary devices that are related to operation of the fire alarm system for life safety. This switch over shall be done on the day of or the day prior to the scheduled testing day**.**

O. Prior to conducting the pretest, the contractor shall switch over modules for tamper switches, flow switches, fire pump controller connections and duct smoke detectors. This switch over shall only be done on the day of or the day prior to the scheduled testing day**.**

P. Prior to the pretest, the contractor shall install and program screen shots with locations of all devices on all floors to all Network Command Centers.

Q. All required testing materials shall be provided by the contractor.

3.8 FIRE ALARM SYSTEM TESTING PROCEDURES WHEN REPLACING EXISTING SYSTEM:

A. Initial Testing with the UMB Fire Marshal shall be as follows:

1. The initial test will consist of the following:

a. Test the operation of all notification appliances through-out the building.

b. Test the operation of all initiating devices and supervisory devices.
c. Test elevator recalls. (All functions)
d. Test mass notification broadcast message from campus police to the building.
e. Test mass notification broadcast message from campus police to the building while the building fire alarm system is activated. The message from campus police shall override building message.
f. Test operation of trouble signals and all programmed buttons on FACP.
G. After the completion of the initial test, UMB Fire Marshal will indicate which devices/systems passed and failed. Further directions will be provided as to whether the old devices can be switched over to the new fire alarm system.

B. Final Testing with the UMB Fire Marshal shall consist of full acceptance test.

C. After final acceptance of the testing by the UMB Fire Marshal, the contractor shall submit NFPA 72 certification for records**.**

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

B. General: Comply with Division 1. Engage factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, adjusting, and maintaining equipment and schedules. Provide minimum of four (4) hours' training.
2. Training Aid: Use approved final version of operation and maintenance manual as training aid.
3. Schedule training with Owner with at least seven (7) days' advance notice.

3.10 ON-SITE ASSISTANCE

A. Occupancy Adjustments: When requested within two (2) years of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to three requested visits to Project site for this purpose.

3.11 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.

3.12 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.

END OF SECTION 283111