



**M&T Bank Stadium**  
HVAC Controls, Lighting  
Controls and Sub-Metering  
Systems Improvements Project

**MSA Project No. 20-071**  
**BKM Project No. 20092.01**

**Project Specifications**

**BID SET**  
**February 12, 2021**

**Owner / Client:**

**The Maryland Stadium Authority**  
The Warehouse at Camden Yards  
333 West Camden Street, Suite 500,  
Baltimore, Maryland 21201

**Commissioning Agent:**

Setty  
3040 Williams Drive, Suite 600  
Fairfax, VA 22031  
P: 703-691-2115

**Design Team:**

**Prime Consultant**

**Mechanical/Plumbing Engineers:**

Burdette, Koehler, Murphy & Associates Inc.  
6300 Blair Hill Lane, Suite 400  
Baltimore, MD 21209  
P: 410-323-0600

**Electrical Engineers:**

WFT Engineering Inc.  
1801 Research Boulevard, Suite 100  
Rockville, MD 20850  
P: 301-230-0811



TABLE OF CONTENTS

DIVISION 00

00 00 00 Cover Page

DIVISION 01 – GENERAL REQUIRMENTS

011000 Summary  
012500 Substitution Procedures  
012600 Contract Modification Procedures  
013100 Project Management and Coordination  
013200 Construction Progress Documentation  
013250 Construction Photographs  
013300 Submittal Procedures  
014000 Quality Requirements  
014200 References  
016000 Product Requirements  
017100 Execution  
017310 Cutting and Patching  
017320 Selective Demolition  
017410 Final Cleaning  
017419 Construction Waste Management and Disposal  
017700 Closeout Procedures  
017823 Operation and Maintenance Data  
017839 Project Record Documents  
017900 Demonstration and Training  
019110 General Commissioning Requirements

DIVISION 23 – HVAC

23 01 00 Basic HVAC Requirements  
23 02 00 Project Closeout - HVAC  
23 05 00 Basic HVAC Materials and Methods  
23 05 93 Testing, Adjusting and Balancing  
23 08 00 Commissioning of HVAC Systems  
23 09 00 Automatic Control Systems (DDC)

DIVISION 25 – INTEGRATED AUTOMATION OF BUILDING CONTROLS

25 01 00 Basic Integration of Controls Requirements

DIVISION 26 – ELECTRICAL

26 01 00 Basic Electrical Requirements  
26 05 19 Low-Voltage Electrical Power Conductors and Cables  
26 05 26 Grounding and Bonding for Electrical Systems  
26 05 29 Hangers and Support for Electrical Systems  
26 05 33 Raceways and Boxes for Electrical Systems  
26 05 53 Identification for Electrical Systems  
26 08 00 Electrical Systems Commissioning  
26 09 10 Electrical Submetering Systems  
26 09 43.23 Lighting Controls  
26 27 26 Wiring Devices

26 28 13	Fuses
26 28 16	Enclosed Switches and Circuit Breakers
26 29 13.03	Manual and Magnetic Motor Controllers
26 32 13.13	Diesel Engine Driven Generator Controls
26 43 13	Surge Protection for Low-Voltage Electrical Power Circuits

DIVISION 27 – TELECOMMUNICATIONS

27 10 00	Telecommunications Structured Cabling
----------	---------------------------------------

SUPPLEMENTAL INFORMATION

1. MSA Solid Waste Management Policy
2. 1997 JCI Control Drawings - AS BUILT
3. 2010 ESI Control Drawings - AS BUILT

## SECTION 011000 - SUMMARY

### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Division 0 for 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:
  - 1. Project information.
  - 2. Work covered by Contract Documents.
  - 3. Access to site.
  - 4. Work restrictions.
  - 5. Specification and drawing conventions.
  - 6. Miscellaneous provisions.

#### 1.3 PROJECT INFORMATION

- A. Project Identification: M&T Bank Stadium Controls Improvements Project
  - 1. MSA Project Number: 20-071
  - 2. Project Location: M&T Bank Stadium, Baltimore, Maryland 21201.
- B. Owner: The Maryland Stadium Authority
- C. Owner's Representative:

Kelly Smulovitz  
Capital Projects and Planning  
The Warehouse at Camden Yards  
333 W. Camden Street  
Baltimore, Maryland 21201  
Phone: 410.812.1560. Email: [ksmulovitz@mdstad.com](mailto:ksmulovitz@mdstad.com)
- D. Engineer: BKM 6300 Blair Hill Lane, Suite 400, Baltimore, Maryland 21209.  
Phone: 410.323.0600. Representative: Craig Parks. Email: [cparks@bkma.com](mailto:cparks@bkma.com)

#### 1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The replacement of the existing HVAC controls, lighting controls, and sub-metering at M&T Bank Stadium in Baltimore, Maryland. Project scope also includes the Generator Plant.
- a. HVAC Controls / Building Automation System (BAS) controls replacement.
    - i. The building's existing BAS consists of a Johnson DDC control network with an Andover Continuum overlay.
    - ii. The replacement of the controls shall be to the sensor, actuator, and valve level for a completely new DDC control system. The intent is to remove and replace all existing pneumatic and DDC controls.
    - iii. All existing equipment and systems connected to the current BAS shall be connected to the new BAS. Additional equipment will be connected to the new BAS and equipment functions thru the BAS shall be increased, including but not limited to:
      - 1. All exhaust fans, unit heaters, cabinet heaters shall be added to the building automation system for disable/enable and status monitoring.
      - 2. All concession exhaust fans and walk in coolers shall be added to the building automation system for status monitoring.
  - b. Lighting Controls replacement
    - i. The building contains an existing Microlite system.
    - ii. The existing lighting control system shall be replaced with a new lighting control system. In addition, the lighting controls shall be integrated into the building automation system.
    - iii. Additional specialty lighting systems are also included in the scope, refer to drawings and Div 26 for additional information.
  - c. Sub-Metering replacement
    - i. The building currently contains an Emon sub metering system.
    - ii. The sub metering system shall be replaced with meters that are compatible with MSA's existing Schneider Power logic Monitoring System.
  - d. Generator Plant – controls replacement
    - i. upgrade of the existing engine generator control with a new monitoring and control panel capable of digital communication with the proposed building automation system upgrades.
- B. Refer to drawings and specifications for additional information and requirements. Description above is a summary and not all inclusive.

#### 1.5 OCCUPIED BUILDING

- A. General: Coordinate the work of this contract with Owner so that the work may be carried out smoothly, and in order to minimize disruption to Owner's building occupants and users.

#### 1.6 ACCESS TO SITE

- A. Use of Site: Limit use of Project site to area within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
  - 1. Interior limits:
    - a. Confine construction operations to outside face of exterior wall and between the inside face of exterior walls and the proposed locations of the temporary dust partitions.
  - 2. Site Limits: Limit site disturbance and exterior building area use, to within the areas as defined in the Owner/Contractor agreement.
- B. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.

#### 1.7 COORDINATION WITH OCCUPANTS

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

#### 1.8 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
  - 1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Hours for accessing the existing building to perform Work is unlimited, unless otherwise indicated by Owner. Contractor is to comply with sound ordinances of the local jurisdiction.
  - 1. Weekend Hours: To be coordinated with owner.
  - 2. Early Morning Hours: To be coordinated with owner. Contractor is to comply with sound ordinances of the local jurisdiction.
  - 3. Hours for Utility Shutdowns: To be coordinated with owner.

4. Hours for Loud demolition and drilling: To be coordinated with owner.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
  1. Notify Engineer and Owner not less than ten (10) days in advance of proposed utility interruptions.
  2. Obtain Engineer's and Owner's written permission before proceeding with utility interruptions.
- D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
  1. Notify Owner not less than ten (10) days in advance of proposed disruptive operations.
  2. Obtain Owner's written permission before proceeding with disruptive operations.
- E. Nonsmoking Building: Smoking is not permitted within the building or within 25 feet of entrances, operable windows, or outdoor-air intakes.
- F. Controlled Substances: Use of tobacco products and other controlled substances within the existing building is not permitted or within 25 feet of entrances, operable windows, or outdoor-air intakes.
- G. Usage of Building Facilities: Contractor access will be limited to the sanctuary interior and first floor. Owner's toilet facilities are not available for Contractors' use. Access to other areas of building will not be allowed unless required to perform Work, and in that instance not until written approval is received from Owner.

#### 1.9 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used situations. These conventions are as follows:
  1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
  2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.



- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
  2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.

PART 2 - (Not Used)

PART 3 - (Not Used)

END OF SECTION 011000

## SECTION 012500 - SUBSTITUTION 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. Section includes administrative and procedural requirements for substitutions.

#### 1.3 DEFINITIONS

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

#### 1.4 ACTION SUBMITTALS

- A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  - 1. Substitution Request Form: Use CSI Form 13.1A or facsimile of form provided in Project Manual.
  - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
    - a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
    - b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.

- c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
  - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
  - e. Samples, where applicable or requested.
  - f. Certificates and qualification data, where applicable or requested.
  - g. List of similar installations for completed projects with project names and addresses and names and addresses of Engineers and owners.
  - h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
  - i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
  - j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
  - k. Cost information, including a proposal of change, if any, in the Contract Sum.
  - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
  - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within **seven (7)** days of receipt of a request for substitution. Engineer will notify Contractor of

acceptance or rejection of proposed substitution within **fifteen (15)** days of receipt of request, or **seven (7)** days of receipt of additional information or documentation, whichever is later.

- a. Forms of Acceptance: Change Order, Construction Change Directive, or Engineer's Supplemental Instructions for minor changes in the Work.
- b. Use product specified if Engineer does not issue a decision on use of a proposed substitution within time allocated.

## 1.5 QUALITY ASSURANCE

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

## 1.6 PROCEDURES

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

# PART 2 - PRODUCTS

## 2.1 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than **fifteen (15)** days prior to time required for preparation and review of related submittals.
  1. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
    - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    - b. Substitution request is fully documented and properly submitted.
    - c. Requested substitution will not adversely affect Contractor's construction schedule.
    - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
    - e. Requested substitution is compatible with other portions of the Work.
    - f. Requested substitution has been coordinated with other portions

of the Work.

- g. Requested substitution provides specified warranty.
- h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Not allowed.

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

## SECTION 012600 - CONTRACT 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 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Requirements:
  - 1. Section 01 25 00 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.

#### 1.3 MINOR CHANGES IN THE WORK

- A. Engineer will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710, "Architect's Supplemental Instructions."

#### 1.4 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Engineer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
  - 1. Work Change Proposal Requests issued by Engineer are not instructions either to stop work in progress or to execute the proposed change.
  - 2. Within time specified in Proposal Request after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
    - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
    - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
    - c. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to,

changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

- B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may propose changes by submitting a request for a change.
1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
  2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
  3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
  4. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
  5. Comply with requirements in Section 01 25 00 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
  6. Proposal Request Form: Use AIA Document G709 for Proposal Requests.

#### 1.5 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Work Changes Proposal Request, Engineer will issue a Change Order for signatures of Owner and Contractor on AIA Document.

#### 1.6 CONSTRUCTION CHANGE DIRECTIVE

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

1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600





## SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

### 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 provisions for coordinating construction operations on Project including, but not limited to, the following:
  - 1. General coordination procedures.
  - 2. Project meetings.
  - 3. Requests for Information (RFI's)
- B. Related Requirements:
  - 1. Section 01 32 00 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
  - 2. Section 01 73 00 "Execution" for procedures for coordinating general installation and field- engineering services, including establishment of benchmarks and control points.
  - 3. Section 01 77 00 "Closeout Procedures" for coordinating closeout of the Contract.

#### 1.3 GENERAL COORDINATION PROCEDURES

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

- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
  - 1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
  - 1. Preparation of Contractor's construction schedule.
  - 2. Preparation of the schedule of values.
  - 3. Installation and removal of temporary facilities and controls.
  - 4. Delivery and processing of submittals.
  - 5. Progress meetings.
  - 6. Preinstallation conferences.
  - 7. Project closeout activities.
- D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
  - 1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

#### 1.4 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
  - 1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Engineer of scheduled meeting dates and times.
  - 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
  - 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Engineer, within three days of the meeting.

- B. Preconstruction Conference: Schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Engineer, but no later than **fifteen (15)** days after execution of the Agreement.
1. Conduct the conference to review responsibilities and personnel assignments.
  2. Attendees: Authorized representatives of Owner Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
  3. Agenda: Discuss items of significance that could affect progress, including the following:
    - a. Tentative construction schedule.
    - b. Phasing.
    - c. Critical work sequencing and long-lead items.
    - d. Designation of key personnel and their duties.
    - e. Lines of communications.
    - f. Procedures for processing field decisions and Change Orders.
    - g. Procedures for RFIs.
    - h. Procedures for testing and inspecting.
    - i. Procedures for processing Applications for Payment.
    - j. Distribution of the Contract Documents.
    - k. Submittal procedures.
    - l. Preparation of record documents.
    - m. Use of the premise and existing building.
    - n. Work restrictions.
    - o. Working hours.
    - p. Owner's occupancy requirements.
    - q. Responsibility for temporary facilities and controls.
    - r. Procedures for moisture and mold control.

- s. Procedures for disruptions and shutdowns.
  - t. Construction waste management and recycling.
  - u. Parking availability.
  - v. Office, work, and storage areas.
  - w. Equipment deliveries and priorities.
  - x. First aid.
  - y. Security.
  - z. Progress cleaning.
4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Progress Meetings: Conduct progress meetings at biweekly intervals.
- 1. Coordinate dates of meetings with preparation of payment requests.
  - 2. Attendees: In addition to representatives of Owner and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
  - 3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
    - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
      - 1) Review schedule for next period.
    - b. Review present and future needs of each entity present, including the following:
      - 1) Interface requirements.

- 2) Sequence of operations.
  - 3) Status of submittals.
  - 4) Deliveries.
  - 5) Off-site fabrication.
  - 6) Access.
  - 7) Site utilization.
  - 8) Temporary facilities and controls.
  - 9) Progress cleaning.
  - 10) Quality and work standards.
  - 11) Status of correction of deficient items.
  - 12) Field observations.
  - 13) Status of RFIs.
  - 14) Status of proposal requests.
  - 15) Pending changes.
  - 16) Status of Change Orders.
  - 17) Pending claims and disputes.
  - 18) Documentation of information for payment requests.
4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
- a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

#### 1.5 REQUESTS FOR INFORMATION (RFIs)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
  1. Engineer will return RFIs submitted to Engineer by other entities controlled by Contractor with no response.

2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
  2. Project number.
  3. Date.
  4. Name of Contractor.
  5. Name of Engineer and Construction Manager.
  6. RFI number, numbered sequentially.
  7. RFI subject.
  8. Specification Section number and title and related paragraphs, as appropriate.
  9. Drawing number and detail references, as appropriate.
  10. Field dimensions and conditions, as appropriate.
  11. Contractor's suggested resolution. If Contractor's solution(s) impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
  12. Contractor's signature.
  13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
- C. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow seven working days for Engineer's response for each RFI.
1. The following RFIs will be returned without action:
    - a. Requests for approval of submittals.
    - b. Requests for approval of substitutions.
    - c. Requests for coordination information already indicated in the Contract Documents.
    - d. Requests for adjustments in the Contract Time or the Contract

Sum.

- e. Requests for interpretation of Engineer's actions on submittals.
- f. Incomplete RFIs or inaccurately prepared RFIs.
- 2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt of additional information.
- 3. Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."
  - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer and Owner in writing within days of receipt of the RFI response.
- D. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly.
  - 1. Project name.
  - 2. Name and address of Contractor.
  - 3. Name and address of Engineer and Construction Manager.
  - 4. RFI number.
  - 5. RFI description.
  - 6. Date the RFI was submitted.
  - 7. Date Engineer's response was received.
- E. On receipt of Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Engineer within seven days if Contractor disagrees with response.
  - 1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
  - 2. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.



PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 31 00

## SECTION 013200 – CONSTRUCTION PROGRESS DOCUMENTATION

### 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 documenting the progress of construction during performance of the Work, including the following:
  - 1. Preliminary Construction Schedule.
  - 2. Contractor's Construction Schedule.
  - 3. Submittals Schedule.
  - 4. Daily construction reports.
  - 5. Material location reports
  - 6. Field condition reports
  - 7. Monthly project status reports
  - 8. Special reports.
- B. All items outlined in this section shall be submitted electronically. All indicated hard copies shall be submitted as well, unless otherwise approved by the Owner and A/E.

#### 1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
  - 1. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times.
  - 2. Predecessor activity is an activity that must be completed before a given activity can be started.
- B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships.

Network calculations determine when activities can be performed and the critical path of Project.

- C. Critical Path: The longest continuous sequence of activities through the network schedule that establishes the minimum overall Project duration and contains no Float Time.
- D. Day: Shall equal one calendar day.
- E. Event: The starting or ending point of an activity.
- F. Float: The measure of leeway in starting and/or completing an activity.
  - 1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
  - 2. Free float is the amount of time a given activity can be delayed without adversely affecting the early start of the successor activity.
  - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
  - 4. Use of float suppression techniques such as preferential sequencing, special lead/lag logic restraints, extended activity times, or imposed dates, other than as required by the Contract, shall be cause for rejection of the Construction Schedule and any revisions or updates.
- G. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail. A sequence of new activities and/or activity revisions that are proposed to be added to the existing schedule to demonstrate the influence of delay and the method for incorporating delays and impacts into the schedule as they are encountered.
- H. Major Area: A story of construction, a separate building, a phasing area or a similar significant construction element.
- I. Milestone: A key or critical point in time for reference or measurement.
- J. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.

#### 1.4 SCHEDULE METHODOLOGY AND WORK BREAKDOWN STRUCTURE (WBS)

- A. The scheduling method to be used shall be a CPM schedule in the form of a Bar-Chart schedule or an activity on node network diagram (Precedence Diagram Method (PDM) format), at the Contractor's option, with capabilities of identifying the critical path.

- B. At the Preconstruction Scheduling Conference, the Contractor shall provide a work breakdown structure (WBS) for the Owner's representative's approval, which shall include the activity identification system for labeling all work activities, including material and equipment procurement, and the associated alpha-numeric coding structure to implement the WBS. The WBS code fields shall be organized as follows:
1. The first code field shall designate the bid item as listed in the bid form;
  2. The second code field shall identify the construction phase, contract milestone, or project element (if phasing of the work, contract milestones, or project elements are identified in the Contract);
  3. The third code field shall identify the type of activity (types of activities shall be defined as "submittal", "review", "re-submittal", "review/approval", "procurement", "fabrication", "delivery", "construction/installation", "cleanup", "punch list", "testing", "training", or "change order");
  4. The fourth code field shall identify the area being worked in or the facility, if appropriate;
  5. The fifth code field shall identify who is responsible to perform the activity (i.e.: the contractor, various subcontractors and suppliers, etc.); and
  6. The sixth code field shall identify which Specification section the activity shall be paid under.
- C. All change orders shall be incorporated into the WBS by separate code fields.

#### 1.5 SUBMITTALS

- A. Qualification Data: For firms and persons specified in "Quality Assurance" Article and in-house scheduling personnel to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Engineers and owners, and other information specified.
- B. Submittals Schedule: Within fourteen (14) days of the Notice to Proceed, submit five (5) copies of submittal schedule. Arrange the following information in a tabular format:
1. Scheduled date for first submittal.
  2. Specification section number and title.
  3. Submittal category (action or informational).
  4. Name of subcontractor.
  5. Description of the work covered.

6. Scheduled date for Engineer's final release or approval.
- C. Preliminary Construction Schedule: Submit five (5) printed copies; one (1) a reproducible media, and four (4) colored prints of sufficient width to show entire schedule for the entire construction period. Include properly annotated legend and a footer containing contractor's name with a title indicating "Preliminary Construction Schedule".
- D. Preliminary Network Diagram: Submit five (5) printed copies; one (1) a single sheet of reproducible media, and four (4) prints of sufficient width to show entire network for entire construction period.
- E. Contractor's Construction Schedule: Submit five (5) printed copies of initial schedule, one a reproducible print and four colored prints of sufficient width to show entire schedule for entire construction period. Include properly annotated legend, a footer containing contractor's name with a title indicating "Contractor's Construction Schedule", and the effective date of the schedule update.
- F. Submit two (2) identical electronic copies of each schedule, in color, two (2) identical copies on CD and labeled to comply with requirements for submittals. Include type of schedule (Initial or Updated) and date on label.
- G. CPM Reports: Concurrent with CPM schedule, submit three (3) printed color copies of each of the following computer-generated reports. Format for each activity in reports shall contain: Activity ID Number, Activity Description, Original Duration, Remaining Duration, Percent Complete, Early Start Date, Early Finish Date, Late Start Date, Late Finish Date, and Total Float.
  1. Activity Report: List of all activities sorted by Activity Number and then Early Start Date, or Actual Start Date if known.
  2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by Activity Number and then Early Start Date, or Actual Start Date if known.
  3. Total Float Report: List of all activities sorted in ascending order of Total Float.
  4. Earnings Report: Compilation of Contractor's total earnings from commencement of the Work until most recent Application for Payment.
- H. Daily Construction Reports: Submit four (4) copies at weekly intervals.
- I. Material Location Reports: Submit four (4) copies at monthly intervals.
- J. Field Condition Reports: Submit (4) four copies at time of discovery of differing conditions.
- K. Monthly Project Status Report: Submit four (4) copies at monthly intervals.

- L. Special Reports: Submit four (4) copies at time of unusual event.

#### 1.6 QUALITY ASSURANCE

- A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting.
- B. Preconstruction Scheduling Conference: Within fourteen (14) calendar days after contractor's receipt of the Notice to Proceed, the Owner's representative will schedule and conduct a Preconstruction Scheduling Conference with the Contractor's Project Manager and Construction Scheduler/Scheduling Consultant to commence development of the required Preliminary Construction Schedule and Contractor's Construction Schedule. At this meeting, the requirements of this Specification section will be reviewed with the Contractor. The Contractor shall be prepared to review and discuss the methodology for preparing the schedules; as his planned sequence of operations and resource and cost loading of the schedule including, but not limited to, the following:
  - 1. Review software limitations and content and format for reports.
  - 2. Verify availability of qualified personnel needed to develop and update schedule.
  - 3. Discuss constraints, including phasing, work stages, area separations, interim milestones, and partial Owner occupancy.
  - 4. Review delivery dates for Owner-furnished products.
  - 5. Review schedule for work of Owner's separate contracts.
  - 6. Review time required for review of submittals and re-submittals.
  - 7. Review requirements for tests and inspections by independent testing and inspecting agencies.
  - 8. Review time required for completion and startup procedures.
  - 9. Review and finalize list of construction activities to be included in schedule.
  - 10. Review submittal requirements and procedures.
  - 11. Review procedures for updating schedule.
- C. The Owner's representative shall have the right to approve or disapprove the use of the Contractor's proposed Scheduling Consultant for this project, and will notify the contractor of its decision within seven (7) calendar days from the Preconstruction Scheduling Conference. In case of disapproval, the Contractor shall resubmit another Scheduling Consultant within seven (7) calendar days for renewed consideration. No progress payments shall be made until the

Contractor's Scheduling Consultant is approved and has submitted an acceptable baseline and an updated Project Schedule consistent with the requirements of this section.

## 1.7 COORDINATION

- A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.
- B. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.
  - 1. Secure time commitments for performing critical elements of the Work from parties involved.
  - 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.
- C. Auxiliary Services: Cooperate with photographer and provide auxiliary services requested, including access to Project site and use of temporary facilities including temporary lighting.

## PART 2 - PRODUCTS

### 2.1 SUBMITTALS SCHEDULE

- A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, re-submittal, ordering, manufacturing, fabrication, and delivery when establishing dates.
  - 1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
  - 2. Initial Submittal: Submit concurrently with Preliminary Network Diagram. Include submittals required during the first sixty (60) days of construction. List those required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
    - a. At Contractor's option, show submittals on the Preliminary Construction Schedule, instead of tabulating them separately.
  - 3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

## 2.2 CONSTRUCTION SCHEDULE FORMATTING REQUIREMENTS

- A. Procedures: Comply with procedures contained in AGC's publication "Construction Planning & Scheduling Manual", latest edition.
- B. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion.
  - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- C. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
  - 1. Activity Duration: Define activities so that no activity is longer than fourteen (14) days, unless specifically allowed by Owner's representative.
  - 2. Procurement Activities: Include procurement process activities for long lead items and major items, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
  - 3. Submittal Review Time: Include review and re-submittal times indicated in Division-01 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with Submittals Schedule.
  - 4. Startup and Testing Time: Include not less than five (5) days for startup and testing.
  - 5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Engineer's administrative procedures necessary for certification of Substantial Completion.
- D. Work Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
  - 1. Phasing: Arrange list of activities on schedule by phase.
  - 2. Work Under More Than One Contract: Include a separate activity for each contract.
  - 3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.



4. Products Ordered in Advance: Include a separate activity for each product. Include delivery date. Delivery dates indicated stipulate the earliest possible delivery date.
5. Owner-Furnished Products: Include a separate activity for each product. Include delivery date. Delivery dates indicated stipulate the earliest possible delivery date.
6. Work Restrictions: Show the effect of the following items on the schedule:
  - a. Coordination with existing construction.
  - b. Limitations of continued occupancies.
  - c. Uninterruptible services.
  - d. Partial occupancy before Substantial Completion.
  - e. Use of premises restrictions.
  - f. Provisions for future construction.
  - g. Seasonal variations.
  - h. Environmental control.
7. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
  - a. Subcontract awards.
  - b. Submittals.
  - c. Purchases.
  - d. Mockups.
  - e. Fabrication.
  - f. Sample testing.
  - g. Deliveries.
  - h. Installation.
  - i. Tests and inspections.
  - j. Adjusting.
  - k. Curing.

1. Startup and placement into final use and operation.
  8. Major Area of Construction: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
    - a. Structural completion
    - b. Permanent space enclosure
    - c. Completion of mechanical installation
    - d. Completion of electrical installation
    - e. Substantial completion
    - f. Mobilization complete
- E. Milestones: All schedules will include, at a minimum, dates for the following Milestones:
  1. Mobilization complete
  2. Completion of Pre-Demolition reports
  3. Building Automation System (BAS) backbone/infrastructure installation
  4. BAS extension and mapping of equipment
  5. Commissioning
- F. Cost Correlation: At the head of schedule, provide a cost correlation line, indicating planned and actual costs. On the line, show dollar volume of the Work performed as of dates used for preparation of payment requests.
  1. Contractor-Initiated Proposals: For each Contractor-Initiated proposal and concurrent with its submission, prepare a time-impact analysis using a fragnet to demonstrate the effect of the proposed change on the current overall construction schedule. Contractor-Initiated Proposals that do not strictly comply with the requirements of this section and related sections will be determined unresponsive and returned to the contractor with no action.
  2. Computer Software: Prepare construction schedules, including the preliminary construction schedule, using Primavera's P3 or SureTrak software. Submit proposed system to Owner's representative for acceptance prior to beginning Construction Schedule.

## 2.3 PRELIMINARY CONSTRUCTION SCHEDULE

- A. Bar-Chart Schedule: Submit preliminary horizontal bar-chart-type construction schedule within seven (7) days of date established for the Notice of Award. The Bar-Chart schedule shall show the sequence and interdependence of activities required for complete performance of the work, beginning with Contractor's Notice To Proceed activity and concluding with the date of Final Completion of the Contract. Bar-Chart schedule must indicate activities on the critical path.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 60 days of construction. Include a forecasted schedule diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

## 2.4 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

- A. General: Prepare network diagrams using AON (activity-on-node) format.
- B. Preliminary Network Diagram: Submit diagram within seven (7) days of date established for the Notice to Proceed. Outline significant construction activities for the first sixty (60) days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.
- C. CPM Schedule: Prepare Contractor's Construction Schedule using a CPM network analysis diagram.
  - 1. Develop network analysis diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 21 days after date established for the Notice to Proceed.
  - 2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
  - 3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
  - 4. Use "one calendar day" as the unit of time.
- D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the Preliminary Network Diagram, prepare a network to identify probable critical paths.
  - 1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
    - a. Preparation and processing of submittals.

- b. Purchase of materials.
    - c. Delivery.
    - d. Fabrication.
    - e. Installation.
  - 2. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
  - 3. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
    - a. Sub networks on separate sheets are permissible for activities clearly off the critical path.
- E. Initial Issue of Schedule: Prepare initial network diagram from a list of straight "Early Start-Total Float" sort. Identify critical activities. Prepare tabulated reports showing the following:
  - 1. Contractor or subcontractor and the Work or activity.
  - 2. Description of activity.
  - 3. Principal events of activity.
  - 4. Immediate preceding and succeeding activities.
  - 5. Early and late start dates.
  - 6. Early and late finish dates.
  - 7. Activity duration in workdays.
  - 8. Total float or slack time.
  - 9. Average size of workforce.
  - 10. Dollar value of activity (coordinated with the Schedule of Values).
- F. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
  - 1. Identification of activities that have changed.
  - 2. Changes in early and late start dates.

3. Changes in early and late finish dates.
4. Changes in activity durations in workdays.
5. Changes in the critical path.
6. Changes in total float or slack time.
7. Changes in the Contract Time.

G. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.

1. In first list, tabulate activity number, Early Finish Date, Dollar Value, and Cumulative Dollar Value.
2. In second list, tabulate activity number, Late Finish Date, Dollar Value, and Cumulative Dollar Value.
3. In subsequent updates of both lists, substitute Actual Finish Dates for activities completed 100% as of list date.
4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
  - a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
  - b. Submit value summary printouts one week before each regularly scheduled progress meeting.

2.5 ACCEPTANCE OF CONTRACTOR'S PRELIMINARY AND CONSTRUCTION SCHEDULES

- A. The Owner's representative will not approve the Contractor's submission of the Preliminary or Construction Schedule and associated submittals. The Owner's representative will accept or reject, in writing, the Contractor's submission of the Preliminary or Construction Schedule and associated submittals. If the schedule is rejected, the Owner's representative shall provide comments in writing to the Contractor stating the reasons why the submittal was rejected.

2.6 COMMENTS BY THE OWNER'S REPRESENTATIVE

- A. Comments made by the Owner's representative on the Preliminary or Construction schedule during review shall not relieve the Contractor from compliance with the requirements of the Contract Documents.
- B. Following the Contractor's receipt of the Owner's representative's review comments, the Contractor shall review the schedule to identify missing activities and relationships relevant to the scope of the work, and no time extensions will

be granted by the Owner's representative to complete activities not initially included in the Contractor's schedule.

- C. To the extent that there are any conflicts between the accepted Schedule and the requirements of the Contract Documents, the Contract Documents shall govern.

## 2.7 RE-SUBMITTAL OF THE CONTRACTOR'S SCHEDULE FOLLOWING REJECTION

- A. Should the Owner's representative reject the Contractor's submission of the Schedule, the Contractor shall comply with the Owner's representative's direction and resubmit the Schedule and all associated submittals within seven (7) calendar days.

## 2.8 FAILURE TO SUBMIT SCHEDULE AND UPDATES

- A. If the Contractor fails to submit the Preliminary or Construction schedule, network diagrams and computer tabulations, or computer diskettes within the time prescribed, the Owner's representative may stop the Contractor's work at no additional cost to the Owner. Further, the Contractor shall not be permitted to mobilize on-site and no mobilization progress payments shall be made until such time as the Contractor submits the required information and obtains acceptance of the baseline Preliminary Construction Schedule. Acceptance of the baseline Preliminary Construction Schedule and subsequent Schedule Updates is a condition precedent to payment of any portion of the Contract amount.

## 2.9 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
1. List of subcontractors at Project site.
  2. List of separate contractors at Project site.
  3. Approximate count of personnel at Project site.
  4. High and low temperatures and 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 authorities having jurisdiction.
  12. Change Orders received and implemented.
  13. Construction Change Directives received.
  14. Services connected and disconnected.
  15. Equipment or system tests and startups.
  16. Partial Completions and occupancies.
  17. Substantial Completions authorized.
- B. Material Location Reports: At monthly intervals, prepare a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site.
- C. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare a detailed report. Submit with a Request for Information form provided by the Owner's representative. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

## 2.10 SPECIAL REPORTS

- A. Monthly Project Status Report: Submit four (4) copies of a monthly progress report covering work accomplished during each period of the contract performance. Submit the first report within thirty (30) days after the issuance of the Notice to Proceed. Submit each subsequent report with each Application for Payment. All applications for payment that do not strictly comply with the requirements of this section and related sections will be determined unresponsive and returned to the contractor with no action. Specific format of the report will be fixed following the Owner's review and comment of the first report. The report is not to be used by the Contractor as an instrument for arguing the validity of claims. The report must be brief, factual and in the following format:
1. Cover page containing:
    - a. Contract number and title.
    - b. Sequence number of report and period of performance reported.
    - c. Contractor's name and address.
    - d. Author.
    - e. Date of report.

2. Section 1: An introduction covering the purpose and scope of the contract effort. In other than the first and final report, this is to be no longer than one paragraph.
  3. Section 2: A description of overall progress and a separate description for each task or other logical segment of work on which effort was expended during the report period. Include pertinent data and/or graphs in sufficient detail to explain significant results achieved.
  4. Section 3: Planned progress for the next report period with a description of current technical or substantive performance and any problem(s) that may impede performance, along with corrective action.
  5. Section 4: Include a copy of the required Construction Schedule.
  6. Section 5: Include a copy of the required Change Order Log.
  7. Section 6: Include a copy of the required Submittal Log.
  8. Section 7: Include a copy of the required RFI Log.
  9. Section 8: Submit progress photographs in accordance with Section 013250.
- B. General: Submit special reports directly to Owner within one (1) day of an occurrence. Distribute copies of report to parties affected by the occurrence.
- C. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the work, prepare and submit a special report. List the chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.
- D. All applications for Payment that do not strictly comply with the requirements of this section and related sections will be determined unresponsive and returned to the contractor with no action.

## PART 3 - EXECUTION

### 3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting using CPM scheduling.
1. In-House Option: Owner may waive the requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. The Contractor must submit qualifications.



2. Meetings: Scheduling consultant shall attend all meetings related to Project progress, alleged delays, and time impact.
- B. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities
1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
  2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
  3. As the Work progresses, indicate Actual Completion percentage for each activity.
- C. Distribution: Distribute copies of approved schedule to the Owner's representative, Owner, Engineer, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
  2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

#### PART 4 – ADJUSTMENT OF CONTRACTOR'S EFFORT

##### 4.1 REQUIRED EFFORTS TO PUT WORK BACK ON SCHEDULE

- A. Whenever it becomes apparent that any activity completion date may not be met, the Contractor shall take the following actions at no additional cost to the Owner.
1. Increase construction manpower to put work back on schedule;
  2. Increase the number of work hours per shift, shifts per day, work days per week, amount of construction equipment, or all or any combination of these actions to put work back on schedule.
  3. Reschedule activities to achieve maximum practical concurrence to place the work back on schedule.
- B. The Owner's representative may also require the Contractor to submit for acceptance at no additional cost to the Owner such supplementary progress schedules, associated reports, and other supporting data as may be deemed necessary to demonstrate the manner in which the accepted Construction schedule will be regained.

- C. The Owner's representative reserves the right to re-sequence or prioritize the Work as necessary to meet project objectives without additional cost to the Owner.

#### 4.2 CONTRACTOR'S FAILURE TO COMPLY

- A. Failure of the Contractor to comply with the requirements of the Owner's representative under this Part 4 shall be grounds for a determination by the Owner's representative that the Contractor is not prosecuting the work with such diligence as will insure completion within the time of times specified. Upon such determination, the Owner's representative may terminate the Contractor's right to proceed with the work, or any separable part thereof, in accordance with the applicable provisions of the Conditions of the Construction Contract.

END OF SECTION 013200



## SECTION 013250 – CONSTRUCTION PHOTOGRAPHS

### PART 1 – GENERAL

#### 1.1 SUMMARY

##### A. Description of Work:

1. Provide digital photographs and video (on DVD's) of construction prior to commencement of Work and thereafter during progress of Work.
2. Prepare video (on DVD's) of progress of work, coordinated with digital images.
3. Computer files shall become property of Owner.

##### B. Provide photographs and video (on DVD's) of the inside of the building particularly noting the existing condition of the walls, countertops, flooring, and ceiling.

1. Should the contractor utilize portions of the building as a staging area – this area must be approved by the Owner's representative and its condition photographically documented prior to utilization.

#### 1.2 SUBMITTALS

- A. Submit computer files and four copies of each required print, mounted and labeled.
- B. Submit photographs and computer files monthly, to accompany monthly Application for Payment.

#### 1.3 QUALITY ASSURANCE

- A. Provide high resolution video and digital photographs. Provide auxiliary lighting as required to produce clear, well-lit photographs without obscuring shadows.
- B. Depth of field is to be maximum range and within focus to clearly show Work. Photographs with blurry out-of-focus areas will not be accepted.
- C. Clean Work prior to photographing, so that dirt and other foreign matter do not obscure detail.

### PART 2 – PRODUCTS

#### 2.1 VISUAL MEDIA

##### A. Photographs:

1. Print type: Color digital glossy finish prints.

2. Size: 8 inches x 10 inches
  3. Date stamp: Unless otherwise indicated, date and time stamp each photograph as it is being taken so that stamp is integral to photograph.
  4. Mounting: Insert each print in punched clear plastic sleeve suitable for insertion into binder.
- B. Video: Minimum 30 minute DVD.
- C. Labeling: Affix label to bottom of each print or cassette with the following information:
1. Project name.
  2. Date of exposure.
  3. Description of location or view of exposure.
  4. Key plan of building, indicating general location and direction of photograph.

### PART 3 – EXECUTION

#### 3.1 INITIAL SURVEY

- A. Prior to commencement of construction operations, prepare a videotape survey of the site, neighboring property, buildings, roads, sidewalks, trees, and improvements.
1. Document existing conditions and provide written narrative of damage noted.
  2. Survey will be used as a benchmark of existing conditions prior to commencement of construction.
  3. Note any elements or areas that may require special protection during construction operations.

#### 3.2 PROGRESS PHOTOGRAPHS

- A. Upon commencement of Work and once a month, at same time of each month, through final completion of Work, provide the following photographs:
1. Locations:
    - a. Owner will determine locations from which photographs will be taken.
    - b. Such locations will remain fixed during progress of Work.

2. Quantity:

- a. Exterior: Minimum of 8.
- b. Interior: Minimum of 12 for each floor.

B. Submit 15-30 minute DVD of areas photographed, as directed by Owner.

END OF SECTION 013250



## SECTION 013300 - 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. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Related Requirements:
  - 1. Section 01 32 00 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
  - 2. Section 01 78 23 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
  - 3. Section 01 78 39 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.

#### 1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Engineer'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 Engineer'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."
- C. 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.

#### 1.4 ACTION SUBMITTALS

- A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Engineer and additional time for handling and reviewing submittals required by those corrections.



1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
  - a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
4. Format: Arrange the following information in a tabular format:
  - a. Scheduled date for first submittal.
  - b. Specification Section number and title.
  - c. Submittal category: Action; informational.
  - d. Name of subcontractor.
  - e. Description of the Work covered.
  - f. Scheduled date for Engineer's final release or approval.

#### 1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Engineer's Digital Data Files: Electronic digital data files of the Contract Drawings will not be provided by Engineer for Contractor's use in preparing submittals.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
  1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
  2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
  3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
  4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review

submittals concurrently for coordination.

- a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer'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 10 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
  2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
  3. Resubmittal Review: Allow 5 days for review of each resubmittal.
  4. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Engineer and to Engineer's consultants, allow 10 days for review of each submittal. Submittal will be returned to Engineer before being returned to Contractor.
- D. Paper Submittals: Place a permanent label or title block on each submittal item for identification.
1. Indicate name of firm or entity that prepared each submittal on label or title block.
  2. Provide a space approximately 6 by 8 inches on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.
  3. Include the following information for processing and recording action taken:
    - a. Project name.
    - b. Date.
    - c. Name of Engineer.
    - d. Name of Construction Manager.
    - e. Name of Contractor.

- f. Name of subcontractor.
  - g. Name of supplier.
  - h. Name of manufacturer.
  - i. Submittal number or other unique identifier, including revision identifier.
    - 1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).
  - j. Number and title of appropriate Specification Section.
  - k. Drawing number and detail references, as appropriate.
  - l. Location(s) where product is to be installed, as appropriate.
  - m. Other necessary identification.
4. Additional Paper Copies: Unless additional copies are required for final submittal, and unless Engineer observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
- a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Engineer.
5. Transmittal for Paper Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Engineer will return without review submittals received from sources other than Contractor.
- a. Transmittal Form for Paper Submittals: Provide locations on form for the following information:
    - 1) Project name.
    - 2) Date.
    - 3) Destination (To:).
    - 4) Source (From:).
    - 5) Name and address of Engineer.
    - 6) Name of Construction Manager.

- 7) Name of Contractor.
- 8) Name of firm or entity that prepared submittal.
- 9) Names of subcontractor, manufacturer, and supplier.
- 10) Category and type of submittal.
- 11) Submittal purpose and description.
- 12) Specification Section number and title.
- 13) Specification paragraph number or drawing designation and generic name for each of multiple items.
- 14) Drawing number and detail references, as appropriate.
- 15) Indication of full or partial submittal.
- 16) Transmittal number, numbered consecutively.
- 17) Submittal and transmittal distribution record.
- 18) Remarks.
- 19) Signature of transmitter.

E. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:

1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.
  - a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).
3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Engineer.
4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner, containing the following information:
  - a. Project name.

- b. Date.
  - c. Name and address of Engineer.
  - d. Name of Construction Manager.
  - e. Name of Contractor.
  - f. Name of firm or entity that prepared submittal.
  - g. Names of subcontractor, manufacturer, and supplier.
  - h. Category and type of submittal.
  - i. Submittal purpose and description.
  - j. Specification Section number and title.
  - k. Specification paragraph number or drawing designation and generic name for each of multiple items.
  - l. Drawing number and detail references, as appropriate.
  - m. Location(s) where product is to be installed, as appropriate.
  - n. Related physical samples submitted directly.
  - o. Indication of full or partial submittal.
  - p. Transmittal number, numbered consecutively.
  - q. Submittal and transmittal distribution record.
  - r. Other necessary identification.
  - s. Remarks.
- F. Options: Identify options requiring selection by Engineer.
- G. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Engineer on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- H. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
- 1. Note date and content of previous submittal.

2. Note date and content of revision in label or title block and clearly indicate extent of revision.
  3. Resubmit submittals until they are marked with approval notation from Engineer's action stamp.
- I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- J. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Engineer's action stamp.

## PART 2 - PRODUCTS

### 2.1 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
1. Submit electronic submittals via email as PDF electronic files.
    - a. Engineer will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
  2. Action & Informational Submittals: Submit three paper copies of each submittal unless otherwise indicated. Engineer will return two copies.
  3. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
    - a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
  2. Mark each copy of each submittal to show which products and options are applicable.

3. Include the following information, as applicable:
    - a. Manufacturer's catalog cuts.
    - b. Manufacturer's product specifications.
    - c. Standard color charts.
    - d. Statement of compliance with specified referenced standards.
    - e. Testing by recognized testing agency.
    - f. Application of testing agency labels and seals.
    - g. Notation of coordination requirements.
    - h. Availability and delivery time information.
  4. For equipment, include the following in addition to the above, as applicable:
    - a. Wiring diagrams showing factory-installed wiring.
    - b. Printed performance curves.
    - c. Operational range diagrams.
    - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
  5. Submit Product Data before or concurrent with Samples.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
    - a. Identification of products.
    - b. Schedules.
    - c. Compliance with specified standards.
    - d. Notation of coordination requirements.
    - e. Notation of dimensions established by field measurement.
    - f. Relationship and attachment to adjoining construction clearly

g. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 42 inches.
3. Submit Shop Drawings in the following format:
  - a. PDF electronic file.
  - b. Three opaque copies of each submittal. Engineer will retain one copy; remainder will be returned.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.

2. Identification: Attach label on unexposed side of Samples that includes the following:

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

3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.

4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

- a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.

- b. Samples not incorporated into the Work, or otherwise designated



as Owner's property, are the property of Contractor.

5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
    - a. Number of Samples: Submit one full set of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Engineer will return submittal with options selected.
  6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
- E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
  2. Manufacturer and product name, and model number if applicable.
  3. Number and name of room or space.
  4. Location within room or space.
  5. Submit product schedule in the following format:
    - a. PDF electronic file.
    - b. Three paper copies of product schedule or list unless otherwise indicated. Engineer will return two copies.
- F. Coordination Drawing Submittals: Comply with requirements specified in Section 013100 "Project Management and Coordination."
- G. Contractor's Construction Schedule: Comply with requirements specified in Section 013200 "Construction Progress Documentation."
- H. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 014000 "Quality Requirements."
- I. Closeout Submittals and Maintenance Material Submittals: Comply with

requirements specified in Section 017700 "Closeout Procedures."

- J. Maintenance Data: Comply with requirements specified in Section 017823 "Operation and Maintenance Data."
- K. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of Engineers and owners, and other information specified.
- L. 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.
- M. 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.
- N. 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.
- O. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- P. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- Q. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- R. 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.
- S. 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:
  - 1. Name of evaluation organization.
  - 2. Date of evaluation.
  - 3. Time period when report is in effect.

4. Product and manufacturers' names.
  5. Description of product.
  6. Test procedures and results.
  7. Limitations of use.
- T. 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.
- U. 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.
- V. 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.
- W. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

### PART 3 - EXECUTION

#### 3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.
- B. Project Closeout and Maintenance Material Submittals: See requirements in Section 017700 "Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

### 3.2 ENGINEER'S ACTION

- A. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or revisions required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.
- B. Informational Submittals: Engineer will review each submittal and will not return it, or will return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.
- C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Engineer.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Submittals not required by the Contract Documents may be returned by the Engineer without action.

END OF SECTION 013300



## SECTION 014000 - QUALITY REQUIREMENTS

### 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 quality assurance and quality control.
- B. Testing and inspecting services are contracted by Owner but are to be scheduled by CM.

#### 1.3 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Engineer.
- C. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- D. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.
- E. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- F. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- G. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
  - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

- H. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

#### 1.4 CONFLICTING REQUIREMENTS

- A. Referenced Standards: If compliance with two 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 conflicting requirements that are different, but apparently equal, to Engineer for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data: For Contractor's quality-control personnel.
- C. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- D. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
  - 1. Specification Section number and title.
  - 2. Entity responsible for performing tests and inspections.
  - 3. Description of test and inspection.
  - 4. Identification of applicable standards.
  - 5. Identification of test and inspection methods.
  - 6. Number of tests and inspections required.
  - 7. Time schedule or time span for tests and inspections.
  - 8. Requirements for obtaining samples.
  - 9. Unique characteristics of each quality-control service.

## 1.6 CONTRACTOR'S QUALITY-CONTROL PLAN

- A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than 5 days prior to preconstruction conference. Submit in format acceptable to Engineer. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.
- B. Quality-Control Personnel Qualifications: Engage qualified full-time personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
  - 1. Project quality-control manager may also serve as Project superintendent.
- C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
- D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
  - 1. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections.
  - 2. Special inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections."
  - 3. Owner-performed tests and inspections indicated in the Contract Documents, including tests and inspections indicated to be performed by the Commissioning Authority.
- E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Engineer has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

## 1.7 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
  - 1. Date of issue.



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

1. Name, address, and telephone number of factory-authorized service representative making report.
  2. Statement that equipment complies with requirements.
  3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
  4. Statement whether conditions, products, and installation will affect warranty.
  5. Other required items indicated in individual Specification Sections.
- D. Permits, Licenses, and Certificates: For Owner'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 for compliance with standards and regulations bearing on performance of the Work.

#### 1.8 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.
- F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

- G. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- H. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

## 1.9 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
  - 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
  - 2. Payment for these services will be made from testing and inspecting allowances, as authorized by Change Orders.
  - 3. Costs for re-testing and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
  - 1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
  - 2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
    - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
  - 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
  - 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
  - 5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.

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

- testing and inspecting. Assist agency in obtaining samples.
- 4. Facilities for storage and field curing of test samples.
- 5. Delivery of samples to testing agencies.
- 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
- 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
  - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.
  - 1. Distribution: Distribute schedule to Owner, Engineer, Commissioning Authority, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

#### 1.10 SPECIAL TESTS AND INSPECTIONS

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

6. Re-testing and re-inspecting corrected work.

1.11 CONTRACTOR'S INSPECTION SCHEDULE

- A. Inspection Schedule: Submit a separate inspection schedule that is coordinated with the construction schedule within 90 days of date established for commencement of the Work. Schedule shall document inspection noting the work, time frames and dates for all inspections and services being completed as part of the project. A service report shall be submitted concurrently.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION ACTIVITIES

- A. Prior to work taking place, the contractor is to notify the Owner of all inspection and testing requests to the Owner's third-party inspection and testing company. Inspections not required by Owner, County and State agencies or authorities, or the A/E will be charged to the contractor.

3.2 TEST AND INSPECTION LOG

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

3.3 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
  - 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract

Document requirements for cutting and patching in Section 017300  
"Execution."

- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

## SECTION 014200 - REFERENCES

### PART 1 - GENERAL

#### 1.1 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 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Contract Documents": The "Contract Documents" shall include the "Contract Drawings" and "Contract Specifications" (as well as other documents) as stated in the Conditions of the Contract. The "Contract Drawings" and the "Contract Specifications" are complimentary. In any case where there is a difference between the requirements as described by either the "Contract Drawings" or the "Contract Specifications" the more stringent requirement shall rule.
- C. "Approved": When used to convey Engineer's action on Contractor's submittals, applications, and requests, "approved" is limited to Engineer's duties and responsibilities as stated in the Conditions of the Contract.
- D. "Directed": A command or instruction by Engineer. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- E. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- F. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- G. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- H. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- I. "Provide": Furnish and install, complete and ready for the intended use.
- J. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the



description of the land on which Project is to be built.

### 1.3 INDUSTRY STANDARDS

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

### 1.4 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."
- B. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

IAPMO	International Association of Plumbing and Mechanical Officials	(909) 472-4100
	<a href="http://www.iapmo.org">www.iapmo.org</a>	

ICC	International Code Council	(888) 422-7233
	<a href="http://www.iccsafe.org">www.iccsafe.org</a>	

ICC-ES	ICC Evaluation Service, LLC	(800) 423-6587
	<a href="http://www.icc-es.org">www.icc-es.org</a>	(562) 699-0543

- C. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CPSC	Consumer Product Safety Commission <a href="http://www.cpsc.gov">www.cpsc.gov</a>	(800) 638-2772 (301) 504-7923
DOC	Department of Commerce National Institute of Standards and Technology <a href="http://www.nist.gov">www.nist.gov</a>	(301) 975-4040
DOE	Department of Energy <a href="http://www.energy.gov">www.energy.gov</a>	(202) 586-9220
EPA	Environmental Protection Agency <a href="http://www.epa.gov">www.epa.gov</a>	(202) 272-0167
FAA	Federal Aviation Administration <a href="http://www.faa.gov">www.faa.gov</a>	(866) 835-5322
FG	Federal Government Publications <a href="http://www.gpo.gov">www.gpo.gov</a>	(202) 512-1800
GSA	General Services Administration <a href="http://www.gsa.gov">www.gsa.gov</a>	(800) 488-3111 (202) 619-8925
HUD	Department of Housing and Urban Development <a href="http://www.hud.gov">www.hud.gov</a>	(202) 708-1112
LBL	Lawrence Berkeley National Laboratory Environmental Energy Technologies Division <a href="http://eetd.lbl.gov">http://eetd.lbl.gov</a>	(510) 486-4000
OSHA	Occupational Safety & Health Administration <a href="http://www.osha.gov">www.osha.gov</a>	(800) 321-6742
SD	Department of State <a href="http://www.state.gov">www.state.gov</a>	(202) 647-4000
TRB	Transportation Research Board National Cooperative Highway Research Program <a href="http://www.trb.org">www.trb.org</a>	(202) 334-2934
USDA	Department of Agriculture Agriculture Research Service U.S. Salinity Laboratory <a href="http://www.ars.usda.gov">www.ars.usda.gov</a>	(202) 720-3656
USDA	Department of Agriculture Rural Utilities Service <a href="http://www.usda.gov">www.usda.gov</a>	(202) 720-2791
USDJ	Department of Justice Office of Justice Programs National Institute of Justice <a href="http://www.ojp.usdoj.gov">www.ojp.usdoj.gov</a>	(202) 307-0703

USP	U.S. Pharmacopeia	(800) 227-8772
	<a href="http://www.usp.org">www.usp.org</a>	(301) 881-0666
USPS	United States Postal Service	(202) 268-2000
	<a href="http://www.usps.com">www.usps.com</a>	

D. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CFR	Code of Federal Regulations Available from Government Printing Office <a href="http://www.gpo.gov/fdsys">www.gpo.gov/fdsys</a>	(866) 512-1800 (202) 512-1800
DOD	Department of Defense Military Specifications and Standards Available from Department of Defense Single Stock Point <a href="http://dodssp.daps.dla.mil">http://dodssp.daps.dla.mil</a>	(215) 697-2664
DSCC	Defense Supply Center Columbus (See FS)	
FED-STD	Federal Standard (See FS)	
FS	Federal Specification Available from Department of Defense Single Stock Point <a href="http://dodssp.daps.dla.mil">http://dodssp.daps.dla.mil</a> Available from Defense Standardization Program <a href="http://www.dsp.dla.mil">www.dsp.dla.mil</a> Available from General Services Administration <a href="http://www.gsa.gov">www.gsa.gov</a> Available from National Institute of Building Sciences/Whole Building Design Guide <a href="http://www.wbdg.org/ccb">www.wbdg.org/ccb</a>	(215) 697-2664       (800) 488-3111 (202) 619-8925 (202) 289-7800
MILSPEC	Military Specification and Standards (See DOD)	
USAB	United States Access Board <a href="http://www.access-board.gov">www.access-board.gov</a>	(800) 872-2253 (202) 272-0080
USATBCB	U.S. Architectural & Transportation Barriers Compliance Board (See USAB)	

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200



## SECTION 016000 - PRODUCT REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
  - 1. Section 01 25 00 "Substitution Procedures" for requests for substitutions.

#### 1.2 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
  - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
  - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
  - 3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

#### 1.3 ACTION SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  - 1. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Engineer will notify Contractor of approval or rejection of proposed comparable product request within 15 days of

receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

- a. Form of Approval: As specified in Section 01 33 00 "Submittal Procedures."
  - b. Use product specified if Engineer does not issue a decision on use of a comparable product request within time allocated.
- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 01 33 00 "Submittal Procedures." Show compliance with requirements.

#### 1.4 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

#### 1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
- 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
  - 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
  - 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
  - 4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
- 1. Store products to allow for inspection and measurement of quantity or counting of units.
  - 2. Store materials in a manner that will not endanger Project structure.
  - 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.

4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.

## 1.6 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
  1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
  2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
  1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
  2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
  3. Refer to other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 01 77 00 "Closeout Procedures."

## PART 2 - PRODUCTS

### 2.2 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
  1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
  2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.



3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Engineer will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.

B. Product Selection Procedures:

1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
3. Products:
  - a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
  - b. Nonrestricted List: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.
4. Manufacturers:
  - a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
  - b. Nonrestricted List: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.
5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers,

provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

- C. Visual Matching Specification: Where Specifications require "match Engineer's sample", provide a product that complies with requirements and matches Engineer's sample. Engineer's decision will be final on whether a proposed product matches.
  - 1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 01 25 00 "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Engineer from manufacturer's full range" or similar phrase, select a product that complies with requirements. Engineer will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

## 2.3 COMPARABLE PRODUCTS

- A. Conditions for Consideration: Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer may return requests without action, except to record noncompliance with these requirements:
  - 1. Evidence that the proposed product does not require 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 those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, 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 Engineers and owners, if requested.
  - 5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 60 00



## SECTION 017300 - EXECUTION

### 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 general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
  - 1. Construction layout.
  - 2. Installation of the Work.
  - 3. Cutting and patching.
  - 4. Progress cleaning.
  - 5. Starting and adjusting.
  - 6. Protection of installed construction.
  - 7. Correction of the Work
- B. Related Requirements:
  - 1. Section 01 10 00 "Summary" for limits on use of Project site.
  - 2. Section 01 33 00 "Submittal Procedures" for submitting surveys.
  - 3. Section 01 77 00 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

#### 1.3 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer.

- B. Certificates: Submit certificate signed by professional engineer certifying that location and elevation of improvements comply with requirements.
- C. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:
  - 1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
  - 2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
  - 3. Products: List products to be used for patching and firms or entities that will perform patching work.
  - 4. Dates: Indicate when cutting and patching will be performed.
  - 5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.
    - a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

#### 1.5 QUALITY ASSURANCE

- A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
  - 1. Structural Elements: When cutting and patching structural elements, notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection
  - 2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational elements include the following:
    - a. Primary operational systems and equipment.
    - b. Fire separation assemblies.
    - c. Air or smoke barriers.

- d. Fire-suppression systems.
    - e. Mechanical systems piping and ducts.
    - f. Control systems.
    - g. Communication systems.
    - h. Fire-detection and -alarm systems.
    - i. Conveying systems.
    - j. Electrical wiring systems.
    - k. Operating systems of special construction.
  - 3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:
    - a. Water, moisture, or vapor barriers.
    - b. Membranes and flashings.
    - c. Exterior curtain-wall construction.
    - d. Sprayed fire-resistive material.
    - e. Equipment supports.
    - f. Piping, ductwork, vessels, and equipment.
    - g. Noise- and vibration-control elements and systems.
  - 4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- B. Cutting and Patching Conference: Before proceeding, meet at 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.
- C. Manufacturer's Installation Instructions: Obtain and maintain on-site

manufacturer's written recommendations and instructions for installation of products and equipment.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
  - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in- place materials.

## PART 3 - EXECUTION

### 3.2 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work.
  - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utilities.
  - 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
  - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
  - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
  - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:

1. Description of the Work.
  2. List of detrimental conditions, including substrates.
  3. List of unacceptable installation tolerances.
  4. Recommended corrections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

### 3.3 PREPARATION

- A. Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Engineer according to requirements in Section 01 31 00 "Project Management and Coordination."

### 3.4 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Engineer promptly.
- B. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
- C. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- D. Record Log: Maintain a log of layout control work. Record deviations from



required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Engineer and Construction Manager.

### 3.5 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
  - 1. Make vertical work plumb and make horizontal work level.
  - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
  - 4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
  - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer.

2. Allow for building movement, including thermal expansion and contraction.
  3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
  - J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

### 3.6 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
  1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Section 011000 "Summary."
- F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize interruption to occupied areas.
- G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
  2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
  3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
  4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
  5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
  6. Proceed with patching after construction operations requiring cutting are complete.
- H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
  2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
    - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
    - b. Restore damaged pipe covering to its original condition.
  3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
    - a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
  5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

### 3.7 PROGRESS CLEANING

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

- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 01 74 19 "Construction Waste Management and Disposal."
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

### 3.8 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: Comply with qualification requirements in Section 01 40 00 "Quality Requirements."

### 3.9 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 017300

## SECTION 017310 – 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 procedural requirements for cutting and patching.
- B. Related Sections include the following:
  - 1. Division-01 Section "Selective Demolition" for demolition of selected portions of the building for alterations.
  - 2. Divisions-02 through -27 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.

#### 1.3 DEFINITIONS

- A. Cutting: Removal of existing construction necessary to permit installation or performance of other Work.
- B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

#### 1.4 SUBMITTALS

- A. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
  - 1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
  - 2. Changes to Existing Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
  - 3. Products: List products to be used and firms or entities that will perform the Work.
  - 4. Dates: Indicate when cutting and patching will be performed.

5. Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out of service. Indicate how long service will be disrupted.
6. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
7. A/E's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

#### 1.5 QUALITY ASSURANCE

- A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
- B. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.
  1. Primary operational systems and equipment.
  2. Air or smoke barriers.
  3. Fire-protection systems.
  4. Control systems.
  5. Communication systems.
  6. Electrical wiring systems.
- C. Miscellaneous Elements: Do not cut and patch the following elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.
  1. Water, moisture, or vapor barriers.
  2. Membranes and flashings.
  3. Equipment supports.
  4. Piping, ductwork, vessels, and equipment.
  5. Noise- and vibration-control elements and systems.
- D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction

exposed on the exterior or in occupied spaces in a manner that would, in A/E's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner. Normally delete below. Revise if cutting and patching are extensive or if careful coordination between several trades is necessary to avoid conflicts.

#### 1.6 WARRANTY

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

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections of these Specifications.
- B. Existing Materials: Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
  - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of existing materials.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
  - 1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
  - 2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Temporary Support: Provide temporary support of Work to be cut.
- B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.



- D. Existing Services: Where existing services are required to be removed, relocated, or abandoned, bypass such services before cutting to avoid interruption of services to occupied areas.

### 3.3 PERFORMANCE

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
  - 1. Cut existing construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Cutting: Cut existing construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
  - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
  - 2. Existing Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
  - 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
  - 4. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
  - 5. Proceed with patching after construction operations requiring cutting are complete.
- C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.
  - 1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
  - 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
  - a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
4. Ceilings: Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.

END OF SECTION 017310



## SECTION 017320 - SELECTIVE DEMOLITION

### PART 1 – GENERAL

#### 1.1 SUMMARY

- A. This Section includes demolition and removal of selected portions of building or structure.

#### 1.2 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- C. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.
- D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- E. Demolish: Tearing down, destruction, breakup, razing or removal of the whole or part of a building or structure, or a free standing machinery or equipment that is directly related to the function of the structure.
- F. Recycle: Recovery of demolition waste for subsequent processing in preparation for reuse.

#### 1.3 OWNERSHIP OF REMOVED MATERIALS

- A. Prior to demolition operations, the Owner reserves the right to salvage any items that otherwise would be part of the demolition; the Owner will remove equipment, material and fixtures they wish to retain.
- B. After demolition operations begin, equipment, material and fixtures indicated for demolition become the property of the Contractor to be removed, salvaged or disposed of by the Contractor.

#### 1.4 SUBMITTALS

- A. Predemolition Photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by selective demolition operations.
- B. Qualification Data: For refrigerant recovery technician.

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. Informational Submittals:

1. Submit shop drawings showing shoring, bracing, and temporary supports for the existing and re-installed structure as appropriate.
2. Design of Bracing and Support: Submit engineering calculations of shoring and bracing designs.
  - a. Shoring, bracing and support shall be designed to maintain existing lines and surfaces without deflection during work; design shall be in accordance with gravity dead, live and wind load resistance requirements of the jurisdiction.
  - b. Design shall be sufficient for existing and new material loads and anticipated construction loads.
  - c. Stresses on supporting structure shall not exceed safe, commonly allowable stresses for the materials in consideration of their age and conditions.
3. Provide certification of professional engineer responsible for the preparation or review of the shop drawings and design calculations.
4. Construct shoring, bracing and support in accordance with design submittal and proper and standard construction practice.

E. Closeout Submittals:

1. Inventory: Submit a list of items that have been removed and salvaged.
2. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

## 1.5 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.
- B. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.
- C. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- D. Standards: Comply with ANSI A10.6 and NFPA 241.
- E. Predemolition Conference: Conduct conference at Project site to comply with requirements in the Contract Documents.
  - 1. Inspect and discuss condition of construction to be selectively demolished.
  - 2. Review structural load limitations of existing structure.
  - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
  - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
  - 5. Review areas where existing construction is to remain and requires protection.

## 1.6 PROJECT CONDITIONS

- A. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- B. Notify Design Team and Owner of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- C. Hazardous Materials: If materials suspected of containing hazardous materials are encountered, immediately notify Design Team and Owner.
- D. Storage or sale of removed items or materials on-site is not permitted.
- E. 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.

## 1.7 WARRANTY

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

## PART 2 - PRODUCTS

### 2.1 REPAIR MATERIALS

- A. Use repair materials identical to existing materials.
  - 1. If identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
  - 2. Use materials whose installed performance, equals or surpasses that of existing materials.
- B. Comply with material and installation requirements specified in individual Specification Sections.

## PART 3 – EXECUTION

### 3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Design Team.
- D. Engage a professional structural engineer to survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective demolition operations.
- E. Survey of Existing Conditions:
  - 1. Record existing conditions by use of preconstruction photographs.
  - 2. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

- F. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

### 3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.
  - 1. Comply with requirements for existing services/systems interruptions specified herein or elsewhere as indicated.
  - 2. Comply with requirements IAQ requirements specified herein, or elsewhere as indicated.
- B. Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
  - 1. Arrange to shut off services/systems with utility companies.
  - 2. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
  - 3. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.
    - a. Where entire wall is to be removed, existing services/systems may be removed with removal of the wall.

### 3.3 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
  - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
  - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.



3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
  4. Cover and protect furniture, furnishings, and equipment that have not been removed.
  5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Division-01.
- C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
1. Strengthen or add new supports when required during progress of selective demolition.

#### 3.4 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated.
- B. The Demolition Drawings or notes are general in nature and intended as a guide to the Contractor, but the Contractor shall include in their Base Bid all demolition required to complete the new work whether shown on the Demolition Plan or not. No additional compensation will be granted for any demolition work required in order to complete new work.
- C. Use methods required to complete the Work within limitations of governing regulations and as follows:
1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
  2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
  3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
  4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.

5. Maintain adequate ventilation when using cutting torches.
  6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
  7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
  8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
  9. Dispose of demolished items and materials promptly.
- D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Owner, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

### 3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in small sections. Cut concrete to a depth of at least 3/4 inch at junctures with construction to remain, using power-driven saw. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete indicated for selective demolition. Neatly trim openings to dimensions indicated.
- B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.
- C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.
- D. Concrete Floor/Ceiling Deck: Cut deck perimeter clean and through, true and plumb; patch and fill voids and breakaways of slab edge.

### 3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Dispose as indicated herein, or elsewhere as indicated.
  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.

3.7 CLEANING

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

END OF SECTION 017320

## SECTION 017410 – FINAL CLEANING

### PART 1 – GENERAL

#### 1.1 SUMMARY

- A. Description of Work: Work of this Section includes cleaning prior to inspection for final completion of Work.
- B. Requirements for cleaning specified in this Section are in addition to specific cleaning requirements specified in various Specification Sections in Divisions-02 through -27.

### PART 2 - PRODUCTS

#### 2.1 CLEANING MATERIALS

- A. Use materials which will not create hazards to health or property and which will not damage surfaces.
- B. Use materials and methods which comply with requirements of local authorities having jurisdiction over Work and are recommended by manufacturer or fabricator of material being cleaned.

### PART 3 - EXECUTION

#### 3.1 CLEANING

- A. Maintain premises and site in reasonable neat and orderly and safe condition, kept free from accumulations of waste materials and rubbish during entire construction period.
  - 1. Remove crates, cartons, and other flammable waste materials or trash from the work areas at the end of each working day.
  - 2. Do not allow debris to blow onto adjoining properties.
  - 3. Respond immediately to request from adjoining property Owners to remove any debris that does manage to show up on adjoining properties.
  - 4. Maintain premises in neat, orderly and safe condition conducive to construction.
  - 5. Remove waste, wires, scraps, etc. from work areas at the end of each day.
  - 6. Remove dust, dirt and other accumulations and broom sweep daily.
- B. Just prior to Owner occupancy, thoroughly clean exterior of building, as well as grounds, approaches, equipment, sidewalks, streets, and the like, and leave in

good order, with paint surfaces clean and unbroken, hardware clean and polished, required repair work completed and public property cleaned.

1. Dispose of waste and debris legally, in accordance with applicable laws.
- C. Just prior to Owner occupancy, thoroughly clean building, including all visible surfaces and concealed spaces;
1. Sweep and clean construction area thoroughly and remove marks, stains, fingerprints, dust, dirt, paint drippings and the like from surfaces, and wash clean plumbing and fixtures.
  2. Clean metals as well as equipment.
  3. Clean and touch up paint or decorated work.
  4. Remove temporary labels, tags, and paper coverings from building components.
  5. Replace dirty filters.
  6. Remove labels from glass surfaces, clean with soap and water and polish dry.
- D. Maintain Project in clean condition until the Owner accepts the building.
- E. Complete the following cleaning operations before requesting Owner inspection for Substantial Completion:
1. Clean Project Site, yard and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste materials, litter and foreign substances.
  2. Sweep paved areas broom clean. Remove petro-chemical spills, stains and other foreign deposits.
  3. Rake grounds that are neither planted nor paved, to a smooth even-textured surface.
  4. Remove tools, construction equipment, machinery and surplus material from Project Site.
  5. 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.
  6. Restore reflective surfaces to their original condition.
  7. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics and similar spaces.

8. Broom clean concrete floors in unoccupied spaces.
9. Vacuum clean carpet and similar soft surfaces, removing debris and excess nap. Shampoo if required.
10. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other substances that are noticeable vision-obscuring materials.
11. Wipe surfaces of mechanical and electrical equipment, and other similar equipment.
12. Remove excess lubrication, paint and mortar droppings and other foreign substances.
13. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
14. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills. Clean ducts, blowers, and coils if units were operated without filters during construction.
15. Leave Project clean and ready for occupancy.
16. Remove temporary protection and facilities installed during construction to protect previously completed installations during remainder of construction.
17. Comply with governing regulations and safety standards for cleaning operations. Remove waste materials from Project Site and dispose of in accordance with requirements of local authorities having jurisdiction.

END OF SECTION 017410



## SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

### 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 the following:
  - 1. Salvaging nonhazardous demolition and construction waste.
  - 2. Recycling nonhazardous demolition and construction waste.
  - 3. Disposing of nonhazardous demolition and construction waste.
- B. Related Requirements:
  - 1. See “MSA Sustainability Guide” for additional requirements.

#### 1.3 DEFINITIONS

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. General: Achieve end-of-Project rates for salvage/recycling of 75 percent by weight of total non-hazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials including the following:
  - 1. Demolition Waste:
    - a. Metals: Ferrous (Iron, steel, stainless steel, galvanized steel) and non-ferrous (copper, brass, bronze, aluminum) types and containers made from metals such as pails, buckets and beverage cans.
    - b. Asphalt paving.



- c. Concrete.
  - d. Concrete reinforcing steel.
  - e. Electrical conduit.
  - f. Copper wiring.
  - g. Electrical devices.
- 2. Construction Waste:
  - a. Concrete.
  - b. Metals.
  - c. Piping.
  - d. Electrical conduit.
  - e. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:
    - 1) Paper.
    - 2) Cardboard.
    - 3) Boxes.
    - 4) Plastic sheet and film.
    - 5) Polystyrene packaging.
    - 6) Wood crates.
    - 7) Plastic pails.

#### 1.5 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within 7 days of date established for the Notice to Proceed.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Include the following information:
  - 1. Material category.
  - 2. Generation point of waste.

3. Total quantity of waste in tons.
  4. Quantity of waste salvaged, both estimated and actual in tons.
  5. Quantity of waste recycled, both estimated and actual in tons.
  6. Total quantity of waste recovered (salvaged plus recycled) in tons.
  7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
- B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
- C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
- D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
- E. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- G. 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.
- H. LEED Submittal: LEED letter template for Credit MR 2, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met.

#### 1.7 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
- B. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.
- C. Waste Management Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to waste management including, but not

limited to, the following:

1. Review and discuss waste management plan including responsibilities of waste management coordinator.
2. Review requirements for documenting quantities of each type of waste and its disposition.
3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
5. Review waste management requirements for each trade.

#### 1.8 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan according to ASTM E 1609 and requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan. Plan shall comply with PHFA requirements.
- B. Waste Identification: Indicate anticipated types and quantities of demolition, site-clearing, and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.
- C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
  1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
  2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
  3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
  4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.

5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

### 3.1 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
- B. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
  1. Distribute waste management plan to everyone concerned within three days of submittal return.
  2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- C. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
  1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.

### 3.2 SALVAGING DEMOLITION WASTE

- A. Salvaged Items for Reuse in the Work: Salvage items for reuse and handle as follows:
  1. Clean salvaged items.
  2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
  3. Store items in a secure area until installation.
  4. Protect items from damage during transport and storage.

5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
- B. Salvaged Items for Donation: Permitted on Project site.
- C. Salvaged Items for Owner's Use: Salvage items for Owner's use and handle as follows:
  1. Clean salvaged items.
  2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
  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. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.
- E. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.
- F. Plumbing Fixtures: Separate by type and size.
- G. Lighting Fixtures: Separate lamps by type and protect from breakage.
- H. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

### 3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Owner.
- C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.
- D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.

1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
  - a. Inspect containers and bins for contamination and remove contaminated materials if found.
2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor.

#### 3.4 RECYCLING DEMOLITION WASTE

- A. Asphalt Paving: Grind asphalt to maximum 4-inch size.
- B. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.
- C. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
  1. Pulverize concrete to maximum 4-inch size.
- D. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
  1. Clean and stack undamaged, whole masonry units on wood pallets.
- E. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
- F. Metals: Separate metals by type.
  1. Structural Steel: Stack members according to size, type of member, and length.
  2. Remove and dispose of bolts, nuts, washers, and other rough hardware.
- G. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.
- H. Conduit: Reduce conduit to straight lengths and store by type and size.

### 3.5 RECYCLING CONSTRUCTION WASTE

#### A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

#### B. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

#### C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

### 3.6 DISPOSAL OF WASTE

#### A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

#### B. Burning: Do not burn waste materials.

#### C. Burning: Burning of waste materials is permitted only at designated areas on Owner's property, provided required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.

#### D. Disposal: Remove waste materials and dispose of at designated spoil areas on Owner's property.

- E. Disposal: Remove waste materials from Owner's property and legally dispose of them.

END OF SECTION 017419





## SECTION 017700 - CLOSEOUT 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. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
  - 1. Substantial Completion procedures.
  - 2. Final completion procedures.
  - 3. Warranties.
  - 4. Final cleaning.
  - 5. Repair of the Work.
- B. Related Requirements:
  - 1. Section 01 73 00 "Execution" for progress cleaning of Project site.
  - 2. Section 01 78 23 "Operation and Maintenance Data" for operation and maintenance manual requirements.
  - 3. Section 01 78 39 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
  - 4. Requirements of Specification Section 01 91 10 "General Commissioning Requirements".

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For cleaning agents.
- B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- C. Certified List of Incomplete Items: Final submittal at Final Completion.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.

- B. Certificate of Insurance: For continuing coverage.

#### 1.5 MAINTENANCE MATERIAL SUBMITTALS

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

#### 1.6 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
  - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
  - 2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
  - 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
  - 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Engineer. Label with manufacturer's name and model number where applicable.
    - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Engineer's signature for receipt of submittals.
  - 5. Submit test records.
  - 6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial

Completion. List items below that are incomplete at time of request.

1. Advise Owner of pending insurance changeover requirements.
  2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
  3. Complete startup and testing of systems and equipment.
  4. Perform preventive maintenance on equipment used prior to Substantial Completion.
  5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 01 79 00 "Demonstration and Training."
  6. Advise Owner of changeover in heat and other utilities.
  7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
  8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
  9. Complete final cleaning requirements, including touchup painting.
  10. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of **10** days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.
1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
  2. Results of completed inspection will form the basis of requirements for final completion.

#### 1.7 FINAL COMPLETION PROCEDURES

- A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:

1. Submit a final Application for Payment.
  2. Certified List of Incomplete Items: Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
  3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
  4. Submit pest-control final inspection report.
- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

#### 1.8 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
  2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
  3. Include the following information at the top of each page:
    - a. Project name.
    - b. Date.
    - c. Name of Engineer.
    - d. Name of Contractor.
    - e. Page number.

## 1.9 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
  - 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch (215-by-280-mm) paper.
  - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
  - 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
  - 4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
- D. Provide additional copies of each warranty to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

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

## PART 3 - EXECUTION

### 3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental

and antipollution regulations.

- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
    - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
    - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
    - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
    - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
    - e. Remove snow and ice to provide safe access to building.
    - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
    - g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
    - h. Sweep concrete floors broom clean in unoccupied spaces.
    - i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
    - j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
    - k. Remove labels that are not permanent.
    - l. Wipe surfaces of mechanical and electrical equipment, and similar equipment. Remove excess lubrication, paint and mortar

droppings, and other foreign substances.

- m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
- n. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
- o. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
  - 1) Clean HVAC system in compliance with NADCA Standard 1992-01. Provide written report on completion of cleaning.
- a. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
- b. Leave Project clean and ready for occupancy.

- B. Construction Waste Disposal: Comply with waste disposal requirements in Section 01 74 19 "Construction Waste Management and Disposal."

### 3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
  - 1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
  - 2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
    - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
  - 3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.



4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION 017700

## SECTION 017823 - MAINTENANCE DATA

### 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 preparing operation and maintenance manuals.
- B. Related Requirements:
  - 1. Section 01 33 00 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
  - 2. Requirements of Specification Section 01 91 10 "General Commissioning Requirements".

#### 1.3 DEFINITIONS

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

#### 1.4 CLOSEOUT SUBMITTALS

- A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
  - 1. Engineer will comment on whether content of operations and maintenance submittals are acceptable.
  - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operations and maintenance manuals in the following format:
  - 1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Engineer.
    - a. Name each indexed document file in composite electronic index

with applicable item name. Include a complete electronically linked operation and maintenance directory.

- b. Enable inserted reviewer comments on draft submittals.
- 2. Three paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. Engineer will return two copies.
- C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Engineer and Commissioning Authority will comment on whether general scope and content of manual are acceptable.
- D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Engineer will return copy with comments.
  - 1. Correct or revise each manual to comply with Engineer's comments. Submit copies of each corrected manual within 15 days of receipt of Engineer's comments and prior to commencing demonstration and training.

## PART 2 - PRODUCTS

### 2.2 PRODUCT MAINTENANCE MANUALS

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

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

### PART 3 - EXECUTION

#### 3.1 MANUAL PREPARATION

- A. Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.
- B. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- C. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
  - 1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
- D. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1. Do not use original project record documents as part of operation and maintenance manuals.
  2. Comply with requirements of newly prepared record Drawings in Section 017839 "Project Record Documents."
- E. Comply with Section 01 77 00 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 017823

## SECTION 017839 - PROJECT RECORD DOCUMENTS

### 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 project record documents, including the following:
  - 1. Record Drawings.
  - 2. Record Specifications.
  - 3. Record Product Data.
  - 4. Miscellaneous record submittals.
- B. Related Requirements:
  - 1. Section 01 73 00 "Execution" for final property survey.
  - 2. Section 01 77 00 "Closeout Procedures" for general closeout procedures.
  - 3. Section 01 78 23 "Maintenance Data" for maintenance manual requirements.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
  - 1. Number of Copies: Submit number **three (3)** set(s) of marked-up record prints.
  - 2. Number of Copies: Submit copies of record Drawings as follows:
    - a. Initial Submittal:
      - 1) Submit PDF electronic files of scanned record prints.
      - 2) Submit record digital data files.
      - 3) Engineer will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.

- b. Final Submittal:
  - 1) Submit number **one (1)** paper-copy set(s) of marked-up record prints.
  - 2) Submit PDF electronic files of scanned record prints and number one (1) set(s) of prints.
  - 3) Print each drawing, whether or not changes and additional information were recorded.
- B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.
  - 1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.
- D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record- keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.
- E. Reports: Submit written report biweekly indicating items incorporated into project record documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

## PART 2 - PRODUCTS

### 2.2 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
  - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
    - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    - b. Accurately record information in an acceptable drawing technique.

- c. Record data as soon as possible after obtaining it.
  - d. Record and check the markup before enclosing concealed installations.
  - e. Cross-reference record prints to corresponding archive photographic documentation.
- 2. Content: Types of items requiring marking include, but are not limited to, the following:
  - a. Dimensional changes to Drawings.
  - b. Revisions to details shown on Drawings.
  - c. Depths of foundations below first floor.
  - d. Locations and depths of underground utilities.
  - e. Revisions to routing of piping and conduits.
  - f. Revisions to electrical circuitry.
  - g. Actual equipment locations.
  - h. Duct size and routing.
  - i. Locations of concealed internal utilities.
  - j. Changes made by Change Order or Construction Change Directive.
  - k. Changes made following Engineer's written orders.
  - l. Details not on the original Contract Drawings.
  - m. Field records for variable and concealed conditions.
  - n. Record information on the Work that is shown only schematically.
- 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
- 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
- 5. Mark important additional information that was either shown



schematically or omitted from original Drawings.

6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.

## 2.3 RECORD PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
  2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
  3. Note related Change Orders, record Specifications, and record Drawings where applicable.
- B. Format: Submit record Product Data as annotated PDF electronic file.
1. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

## 2.4 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
- A. Format: Submit miscellaneous record submittals as PDF electronic file.
1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

# PART 3 - EXECUTION

## 3.2 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period

for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

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

END OF SECTION 017839



## 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.
- B. Requirements of Specification Section 01 91 10 GENERAL COMMISSIONING REQUIREMENTS.

#### 1.2 SUMMARY

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

#### 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 facilitator and instructor.
- C. Attendance Record: For each training module, submit list of participants and length of instruction time.
- D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Documentation: Submit **three (3)** copies within seven days of end of each training module.
  - 1. Identification: On each copy, provide an applied label with the following information:
    - a. Name of Project

- b. Name and address of videographer.
  - c. Name of Engineer.
  - d. Name of Construction Manager.
  - e. Name of Contractor.
  - f. Date of video recording.
2. Transcript: Prepared and bound in format matching operation and maintenance manuals. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video recording. Include name of Project and date of video recording on each page.
  3. At completion of training, submit complete training manual(s) for Owner's use in PDF electronic file format on compact disc.

#### 1.5 QUALITY ASSURANCE

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

#### 1.6 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 has been reviewed and approved by Engineer.

### PART 2 - PRODUCTS

#### 2.1 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
  1. Basis of System Design, Operational Requirements, and Criteria: Include

the following:

- a. System, subsystem, and equipment descriptions.
  - b. Performance and design criteria if Contractor is delegated design responsibility.
  - c. Operating standards.
  - d. Regulatory requirements.
  - e. Equipment function.
  - f. Operating characteristics.
  - g. Limiting conditions.
  - h. Performance curves.
2. Documentation: Review the following items in detail:
- a. Emergency manuals.
  - b. Operations manuals.
  - c. Maintenance manuals.
  - d. Project record documents.
  - e. Identification systems.
  - f. Warranties and bonds.
  - g. Maintenance service agreements and similar continuing commitments.
3. Emergencies: Include the following, as applicable:
- a. Instructions on meaning of warnings, trouble indications, and error messages.
  - b. Instructions on stopping.
  - c. Shutdown instructions for each type of emergency.
  - d. Operating instructions for conditions outside of normal operating limits.
  - e. Sequences for electric or electronic systems.
  - f. Special operating instructions and procedures.
4. Operations: Include the following, as applicable:

- a. Startup procedures.
  - b. Equipment or system break-in procedures.
  - c. Routine and normal operating instructions.
  - d. Regulation and control procedures.
  - e. Control sequences.
  - f. Safety procedures.
  - g. Instructions on stopping
  - h. Normal shutdown instructions.
  - i. Operating procedures for emergencies.
  - j. Operating procedures for system, subsystem, or equipment failure.
  - k. Seasonal and weekend operating instructions.
  - l. Required sequences for electric or electronic systems.
  - m. Special operating instructions and procedures.
5. Adjustments: Include the following:
- a. Alignments.
  - b. Checking adjustments.
  - c. Noise and vibration adjustments.
  - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
- a. Diagnostic instructions.
  - b. Test and inspection procedures.
7. Maintenance: Include the following:
- a. Inspection procedures.
  - b. Types of cleaning agents to be used and methods of cleaning.
  - c. List of cleaning agents and methods of cleaning detrimental to product.
  - d. Procedures for routine cleaning

- e. Procedures for preventive maintenance.
- f. Procedures for routine maintenance.
- g. Instruction on use of special tools.
- 8. Repairs: Include the following:
  - a. Diagnosis instructions.
  - b. Repair instructions.
  - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
  - d. Instructions for identifying parts and components.
  - e. Review of spare parts needed for operation and maintenance.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

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

#### 3.2 INSTRUCTION

- A. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
  - 1. Schedule training with Owner, through Engineer, with at least seven days' advance notice.
- B. 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.
- C. 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.

END OF SECTION 017900





## SECTION 019110 - GENERAL COMMISSIONING REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

A. Commissioning: Commissioning is a systematic process of validating that all building systems perform interactively according to the design intent and the owner's operational needs. This is achieved by beginning in the design phase and documenting design intent and continuing through construction, acceptance and the warranty period with actual verification of performance. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training. Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents.

1. Documents and ensures requirements are met.
2. Verify that applicable equipment controls and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
3. Verify and document proper performance of equipment and systems.
4. Verify that O&M documentation left on site is complete.
5. Verify that the Owner's operating personnel are adequately trained.
6. Review trends and seasonal checkout.

B. 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.

C. Abbreviations: The following are common abbreviations used in the Specifications and in the Commissioning Plan. Definitions are found in Section 1.6.

O/E - Owner and Design Engineers  
CxA - Commissioning Authority  
CC - Controls Contractor  
CA - Construction Administrator (of O/E)  
Cx - Commissioning  
Cx Plan - Commissioning Plan Document  
EC - Electrical Contractor  
FPT - Functional Performance Test  
CC - General Contractor  
MC - Mechanical Contractor  
OPM - Owner's Project Manager (of the Owner)  
PFC - Pre-functional Checklist

Subs - Subcontractors to General  
TAB - Test, Adjust and Balance Contractor

## 1.2 COORDINATION

- A. Commissioning Team: The members of the commissioning team consist of the Commissioning authority (CxA), Owner's Project Manager (OPM), the design engineers (particularly the mechanical engineer), the Mechanical Contractor (MC), the Electrical Contractor (EC), the TAB representative, the Controls Contractor (CC), any other installing subcontractors or suppliers of equipment. If known, the Owner's building or plant operator/engineer is also a member of the commissioning team.
- B. Management: The CxA is hired by the Owner directly. The CxA directs and coordinates the commissioning activities and reports to the Owner as part of the OPM team. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.
- C. Scheduling: The CxA will work with the OPM and CC according to established protocols to schedule the commissioning activities. The CxA will provide sufficient notice to the CC for scheduling commissioning activities. The CC will integrate all commissioning activities into the master schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.
- D. The CxA will provide the initial schedule of primary commissioning events at the commissioning scoping meeting. The Commissioning Plan - Construction Phase provides a format for this schedule. As construction progresses more detailed schedules are developed by the CxA. The Cx Plan also provides a format for detailed schedules.

## 1.3 COMMISSIONING PROCESS

- A. Commissioning Plan: The Cx Plan described herein is binding on the Contractor. The Cx Plan provides guidance in the execution of the commissioning process. The Cx Plan may be adjusted for a specific project after the initial Cx scope meeting. The Specifications will take precedence over the Cx Plan.
- B. Commissioning Process: The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.
  - 1. Commissioning during construction begins with a scoping meeting conducted by the CxA where the commissioning process is reviewed with the commissioning team members.
  - 2. Additional meetings will be required throughout construction, scheduled by the CxA with necessary parties attending, to plan, scope, coordinate, schedule future activities and resolve problems.

3. Equipment documentation is submitted to the CxA during normal submittals, including detailed startup procedures.
4. In general, the checkout and performance verification proceeds from simple to complex; from component level to equipment to systems and intersystem levels with pre-functional checklists being completed before functional testing.
5. The Subs, under their own direction, execute and document and perform startup and initial checkout. The CxA documents that the checklists and startup were completed according to the approved plans. This may include the CxA witnessing startup of selected equipment.
6. The CxA develops specific equipment and system functional performance test procedures.
7. The procedures are executed by the Subs, under the direction of, and documented by, the CxA.
8. Items of non-compliance in material, installation or setup are corrected at the Sub's expense and the system retested.
9. The CxA reviews the O&M documentation for completeness.
10. Commissioning is completed before substantial completion.
11. The CxA reviews, pre-approves and coordinates the training provided by the Subs and verifies that it was completed.
12. Deferred testing is conducted, as specified or required.

#### 1.4 RELATED WORK

- A. Specific commissioning requirements are given in the following Sections of these Specifications. All of the following Sections apply to the Work of this Section.
  1. 23 08 00 "Commissioning of HVAC Systems" - Controls Lists special requirements and alerts the controls contractor of responsibilities in 23 08 00.
  2. 26 08 00 "Electrical Systems Commissioning" - Controls Lists special requirements and alerts the electrical contractor of responsibilities in 26 08 00.

#### 1.5 RESPONSIBILITIES

- A. The responsibilities of various parties in the commissioning process are provided in this Section. The responsibilities of the trade contractors are identified in each Division:
  1. Division 23: Mechanical.

2. Division 26: Electrical.
- B. All Parties:
1. Follow the Commissioning Plan.
  2. Attend commissioning scoping meeting and additional meetings, as necessary.
- C. Mechanical and Electrical Designers/Engineers (of the Owner)
1. Construction and Acceptance Phase:
    - a. Perform normal submittal review, construction observation, as-built drawing preparation, etc., as contracted. One site observation should be completed just prior to system startup.
    - b. Provide any design narrative and sequences documentation requested by the CxA. The designers shall assist (along with the contractors) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
    - c. Attend commissioning scoping meetings and other selected commissioning team meetings.
    - d. Participate in the resolution of system deficiencies identified during commissioning, according to the contract documents.
    - e. Prepare and submit the final as-built design intent and operating parameters documentation for inclusion in the O&M manuals. Review and approve the O&M manuals.
    - f. From the Contractor's red-line drawings, edit and update one-line diagrams developed as part of the design narrative documentation and those provided by the vendor as shop drawings for the chilled and hot water, condenser water, domestic hot water, supply, return and exhaust air systems and emergency power system.
  2. Warranty Period
    - a. Participate in the resolution of non-compliance, non-conformance and design deficiencies identified during commissioning during warranty-period commissioning.
- D. Commissioning Authority (CxA)
1. The CxA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or

construction management. The CxA may assist with problem-solving non-conformance or deficiencies, but ultimately that responsibility resides with the general contractor and the O/E. The primary role of the CxA is to develop and coordinate the execution of a testing plan, observe and document performance—that systems are functioning in accordance with the documented design intent and in accordance with the Contract Documents. The Contractors will provide all tools to start, check-out and functionally test equipment and systems.

2. Construction and Acceptance Phase

- a. Coordinates and directs the 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, frequently updated timelines and schedules and technical expertise.
- b. Coordinate the commissioning work and, with the PM and CA, ensure that commissioning activities are being scheduled into the master schedule.
- c. Revise, as necessary, the Commissioning Plan - Construction Phase.
- d. Plan and conduct a commissioning scoping meeting and other commissioning meetings.
- e. Request and review additional information required to perform commissioning tasks, including O&M materials, contractor startup and checkout procedures.
- f. Before startup, gather and review the current control sequences and interlocks and work with contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.
- g. Review normal Contractor submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the O/E reviews.
- h. Write and distribute pre-functional tests and checklists.
- i. Develop an enhanced startup and initial systems checkout plan with Subs.
- j. Perform site visits to observe component and system installations. Attend selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.

- k. May witness the HVAC piping test and flushing procedure, sufficient to be confident that proper procedures were followed. Document this testing and include the documentation in O&M manuals. Notify owner's project manager of any deficiencies in results or procedures.
  - l. Verify systems startup by reviewing startup reports and by selected site observation.
  - m. Review TAB execution plan.
  - n. Verify air and water systems balancing by spot testing, by reviewing completed reports and by selected site observation.
  - o. With necessary assistance and review from installing contractors, write the functional performance test procedures for equipment and systems. This may include energy management control system trending, stand-alone data logger monitoring or manual functional testing. Submit to PM for review, and for approval if required.
  - p. Analyze any functional performance trend logs and monitoring data to verify performance.
  - q. Coordinate, witness, and approve manual functional performance tests performed by installing contractors. Coordinate retesting as necessary until satisfactory performance is achieved.
  - r. Maintain a master deficiency and resolution log and a separate testing record. Provide the PM with written progress reports and test results with recommended actions.
  - s. Review equipment warranties to ensure that the Owner's responsibilities are clearly defined.
  - t. Oversee the training of the Owner's operating personnel.
  - u. Compile and maintain a commissioning record.
  - v. Review of the O&M manuals.
  - w. Provide a final commissioning report (as described in this section).
3. Warranty Period
- a. Coordinate and supervise required Functional Performance Testing and deficiency corrections.

E. Construction Administrator of Owner - Owner's Representative (CA)

1. Construction and Acceptance Phase

- a. Facilitate the coordination of the commissioning work by the CxA, and, with the CA and CxA, ensure that commissioning activities are being scheduled into the master schedule.
- b. Review and approve the final Commissioning Plan - Construction Phase.
- c. Attend a commissioning scoping meeting and other commissioning team meetings.
- d. Perform the normal review of Contractor submittals.
- e. Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CxA.
- f. Review and approve the functional performance test procedures submitted by the CxA, prior to testing.
- g. Review commissioning progress and deficiency reports.
- h. Coordinate the resolution of non-compliance and design deficiencies identified in all phases of commissioning.
- i. Sign-off (final approval) on individual commissioning tests as completed and passing. Recommend completion of the commissioning process to the Project Manager.
- j. Assist the CA in coordinating the training of owner personnel.

2. Warranty Period

- a. Assist the CxA as necessary in the seasonal or deferred testing and deficiency corrections required by the specifications.

F. Owner's Project Manager (OPM)

1. Construction and Acceptance Phase

- a. Manage the contract of the O/E and of the CC.
- b. Arrange for facility operating and maintenance personnel to attend various field commissioning activities and field training sessions according to the Commissioning Plan - Construction Phase.
- c. Provide final approval for the completion of the commissioning work.



2. Warranty Period
  - a. Ensure that any seasonal or deferred testing and any deficiency issues are addressed.

G. Controls Contractor (CC to be controls contractor for this project)

1. Construction and Acceptance Phase
  - a. Facilitate the coordination of the commissioning work by the CxA, and with the CC and subs to ensure that commissioning activities are being scheduled and being completed based on the master schedule.
  - b. Include the cost of commissioning **responsibilities** in the total **Bid Amount**.
  - c. Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CxA.
  - d. In each purchase order or subcontract written, include requirements for submittal data, O&M data, commissioning tasks and training.
  - e. Ensure that all Subs execute their commissioning responsibilities according to the Contract Documents and schedule.
  - f. A representative shall attend a commissioning scoping meeting and other necessary meetings scheduled by the CxA to facilitate the Cx process.
  - g. Coordinate the training of owner personnel.
  - h. Prepare O&M manuals, according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
  - i. Ensure checklists are completed during construction.
  - j. Provide all equipment startup sheets with submittals for each piece of equipment being commissioned.
  - k. Coordinate as scheduled all subcontractors and startup testing.
  - l. Provide trends at peak heating and cooling season for commissioning checkout.
2. Warranty Period

- a. Ensure that Subs execute seasonal or deferred functional performance testing, witnessed by the CxA, according to the specifications.
- b. Ensure that Subs correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

## 1.6 DEFINITIONS

Acceptance Phase - phase of construction after startup and initial checkout when functional performance tests, O&M documentation review and training occurs.

Approval - acceptance that a piece of equipment or system has been properly installed and is functioning in the tested modes according to the Contract Documents.

Architect / Engineer (O/E) - the prime consultant (architect) and sub-consultants who comprise the design team, generally the HVAC mechanical designer/engineer and the electrical designer/engineer.

Basis of Design - The basis of design is the documentation of the primary thought processes and assumptions behind design decisions that were made to meet the design intent. The basis of design describes the systems, components, conditions and methods chosen to meet the intent. Some reiterating of the design intent may be included.

Commissioning Authority (CxA) - an independent agent, not otherwise associated with the O/E team members or the Contractor, though he/she may be hired as a subcontractor to them. The CxA directs and coordinates the day-to-day commissioning activities. The CxA does not take an oversight role like the CA. The CxA shall report directly to the OPM.

Commissioning Plan - an overall plan, developed before or after bidding, that provides the structure, schedule and coordination planning for the commissioning process.

Construction Administrator (CA) - an agent of the O/E, tasked with managing and coordinating the construction process for the Owner, as well as managing the contract of the CC. This individual is a primary recipient of commissioning communication.

Contract Documents - the documents binding on parties involved in the construction of this project (drawings, specifications, change orders, amendments, contracts, Cx Plan, etc.).

Contractor - the general contractor or authorized representative.

Control system - the central building energy management control system.

Data logging - monitoring flows, currents, status, pressures, etc. of equipment using stand-alone data loggers separate from the control system.

Deferred Functional Tests - FPTs that are performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions that disallow the test from being performed.

Deficiency - a condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents (that is, does not perform properly or is not complying with the design intent).

Design Narrative or Design Documentation - sections of either the OPR or Basis of Design.

Factory Testing - testing of equipment on-site or at the factory by factory personnel with an Owner's representative present.

Functional Performance Test (FPT) - 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 set point). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. 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 commissioning authority 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. FPTs are performed after prefunctional checklists and startup is complete.

Controls Contractor (CC) - the prime contractor for this project. Generally refers to all the CC's subcontractors as well. Also referred to as the Contractor in some contexts.

Indirect Indicators - indicators of a response or condition, such as a reading from a control system screen reporting a damper to be 100% closed.

Manual Test - using hand-held instruments, immediate control system readouts or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation").

Monitoring - the recording of parameters (flow, current, status, pressure, etc.) of equipment operation using data loggers or the trending capabilities of control systems.

Non-Compliance - see Deficiency.

Non-Conformance - see Deficiency.

Over-written Value - writing over a sensor value in the control system to see the response of a system (e.g., changing the outside air temperature value from 50°F to 75°F to verify economizer operation). See also "Simulated Signal."

Owner-Contracted Tests - tests paid for by the Owner outside the CC's contract and for which the CxA does not oversee. These tests will not be repeated during functional tests if properly documented.

Owner's Project Manager (OPM) - the contracting and managing authority for the owner over the design and/or construction of the project, a staff position. This individual manages and assists the CxA throughout the construction process.

Owner's Project Requirements (OPR) - a dynamic document that provides the explanation of the ideas, concepts and criteria that are considered to be very important to the owner. It is initially the outcome of the programming and conceptual design phases.

Phased Commissioning - commissioning that is completed in phases (by floors, for example) due to the size of the structure or other scheduling issues, in order minimize the total construction time.

Pre-functional Checklist (PFC) - a list of items to inspect, and elementary component tests to conduct, to verify proper installation of equipment, provided by the CxA to the Sub. Pre-functional 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, etc.). However, some pre-functional checklist items entail simple 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 pre-functional refers to before functional testing. Pre-functional checklists augment and are combined with the manufacturer's startup checklist. Even without a commissioning process, contractors typically perform some, if not many, of the pre-functional checklist items a commissioning authority will recommend. However, few contractors document in writing the execution of these checklist items. Therefore, for most equipment, the contractors execute the checklists on their own. The commissioning authority only requires that the procedures be documented in writing, and does not witness much of the pre-functional check listing, except for larger or more critical pieces of equipment.

Sampling - functionally testing only a fraction of the total number of identical or near identical pieces of equipment.

Seasonal Performance Tests - SFT's that are deferred until the system(s) will experience conditions closer to their design conditions.

Simulated Condition - condition that is created for the purpose of testing the response of a system (e.g., applying a hair blower to a space sensor to see the response in a VAV box).

Simulated Signal - disconnecting a sensor and using a signal generator to send an amperage, resistance or pressure to the transducer and DDC system to simulate a sensor value.

Specifications - the construction specifications of the Contract Documents.

Startup - the initial starting or activating of dynamic equipment, including executing pre-functional checklists.

Subs - the subcontractors to the CC who provide and install building components and systems.

Test Procedures - the step-by-step process which must be executed to fulfill the test requirements. The test procedures are developed by the CxA.

Test Requirements - requirements specifying what modes and functions, etc. shall be tested. The test requirements are not the detailed test procedures. The test requirements are specified in the Contract Documents (Sections XX 08 13 for each Division).

Trending - monitoring using the building control system.

Vendor - supplier of equipment.

Warranty Period - warranty period for entire project, including equipment components. Warranty begins at Substantial Completion and extends for at least one year, unless specifically noted otherwise in the Contract Documents and accepted submittals.

XX - Series of drawings or specification sections to be commissioned.

## 1.7 SYSTEMS TO BE COMMISSIONED

A. The systems to be commissioned in the project include but are not limited to:

1. BAS controllers, end devices, and programming.
2. Lighting controllers, end devices, and programming.
3. Submetering controllers, end devices, and programming.
4. Generator controllers, end devices, and programming.
5. Integrated Building Management System controllers, end devices, and programming.
6. IT infrastructure installed under this project.
7. Any other ancillary equipment in the contract documentation.

B. Refer to each Section in each Division listed above for specific installation and performance verification testing requirements. Each Division has commissioning sections specific to the applicable trades work.

## PART 2 - PRODUCTS

### 2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup and initial checkout and required functional performance testing shall be provided by the Division contractor for the equipment being tested. For example, the mechanical contractor of Division 23 shall ultimately be responsible for all standard testing equipment for the HVAC system and controls system in Division 23, except for equipment specific to and used by TAB in their commissioning responsibilities. Two-way radios, ladders and access to equipment shall be provided by the Division Contractor(s).
- B. Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and left on site.
- C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance within the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

### PART 3 - EXECUTION

#### 3.1 MEETINGS

- A. Scoping Meeting: Within 60 days of commencement of construction, the CxA will schedule, plan and conduct a commissioning scoping meeting with the entire commissioning team in attendance. Meeting minutes will be distributed to all parties by the CxA. Information gathered from this meeting will allow the CxA to revise the Draft 2 Commissioning Plan to its "final" version, which will also be distributed to all parties.
- B. Miscellaneous Meetings: Other meetings will be planned and conducted by the CxA as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with particular Subs. The CxA will plan these meetings and will minimize unnecessary time being spent by Subs. For this project, these meetings may be held monthly, until the final 4 months of construction when they may be held as frequently as one per week.

#### 3.2 REPORTING

- A. The CxA will provide regular reports to the OPM with increasing frequency as construction and commissioning progresses.
- B. The CxA will regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling changes through memos, progress reports, etc.

- C. Testing or review approvals and non-conformance and deficiency reports are made regularly with the review and testing as described in later sections.

### 3.3 SUBMITTALS

- A. At minimum, the Submittal Documentation will include the manufacturer and model number, the manufacturer's printed installation and detailed startup procedures, full sequences of operation, O&M data, performance data, any performance test procedures, control drawings and details of owner contracted tests.
- B. The CxA will review submittals related to the commissioned equipment for conformance to the Contract Documents as it relates to the commissioning process, to the functional performance of the equipment and adequacy for developing test procedures. This review is intended primarily to aid in the development of functional testing procedures and only secondarily to verify compliance with equipment specifications. The CxA will notify the OPM or O/E as requested, of items missing or areas that are not in conformance with Contract Documents and which require resubmission.
- C. The CxA may request additional design narrative from the O/E and Controls Contractor, depending on the completeness of the contract documentation and sequences provided with the Specifications.
- D. These submittals to the CxA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor, though the CxA will review them.

### 3.4 STARTUP AND INITIAL CHECKOUT

- A. The following procedures apply to all equipment to be commissioned.
- B. Startup and Initial Checkout Plan: The primary role of the CxA in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures has been completed. Parties responsible for pre-functional checklists and startup are identified in the commissioning scoping meeting and in the checklist forms. Parties responsible for executing functional performance tests are identified in the testing requirements in Sections XX 08 13 and other sections where tests requirements are found.
  - 1. The CxA adapts, if necessary, the representative pre-functional checklists and procedures. These checklists indicate required procedures to be executed as part of startup and initial checkout of the systems and the party responsible for their execution.
  - 2. These checklists and tests are provided by the CxA to the Contractor. The Contractor determines which trade is responsible for executing and documenting each of the line item tasks and notes that trade on the form.
  - 3. The subcontractor responsible for the purchase of the equipment develops the full startup plan by combining (or adding to) the CxA's checklists with

the manufacturer's detailed startup and checkout procedures from the O&M manual and the normally used field checkout sheets. The plan will include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.

4. The subcontractor submits the full startup plan to the CxA for review.
5. The CxA reviews the procedures and the format for documenting them, noting any procedures that need to be added.
6. The full startup procedures and the approval form may be provided to the OPM for review and approval, depending on management protocol.

C. Deficiencies, Non-Conformance and Approval in Startup

1. The Subs shall clearly list any outstanding items of the initial startup that were not completed successfully, at the bottom of the procedures form or on an attached sheet. **The procedures form and any outstanding deficiencies are provided to the CxA within two days of test completion.**
2. The CxA reviews the report and submits either a non-compliance report or an approval form to the Sub or OPM. The CxA shall work with the Subs and vendors to correct and retest deficiencies or uncompleted items. The CxA will involve the OPM and others as necessary. The installing Subs or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the CxA as soon as outstanding items have been corrected and resubmit an updated startup report and a Statement of Correction on the original non-compliance report. When satisfactorily completed, the CxA recommends approval of the execution of the checklists and startup of each system to the OPM using a standard form.
3. Items left incomplete, which later cause deficiencies or delays during functional testing may result in back charges to the responsible party. Refer to Part 3.7 herein for details.

3.5 PHASED COMMISSIONING

- A. The project may require startup and initial checkout to be executed in phases. This phasing will be planned and scheduled in a coordination meeting of the CxA, OPM, Mechanical Contractor, TAB and Controls Contractor, and the CC. Results will be added to the master and commissioning schedule.

3.6 FUNCTIONAL PERFORMANCE TESTING

- A. This sub-section applies to all commissioning functional testing for all divisions.

- B. The general list of equipment to be commissioned is found in contract documentation.
- C. Objectives and Scope: The objective of functional performance testing is to demonstrate that each system is operating according to the documented Owner's Project Requirements and Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.
- D. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. shall also be tested.
- E. Test Methods
  - 1. Functional performance testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data loggers. Sections XX 08 13 specify which methods shall be used for each test. The CxA may substitute specified methods or require an additional method to be executed, other than what was specified, with the approval of the OPM. This may require a change order and adjustment in charge to the Owner. The CxA will determine which method is most appropriate for tests that do not have a method specified.
  - 2. Simulated Conditions: Simulating conditions (not by an overwritten value) shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.
  - 3. Overwritten Values: Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, shall be allowed, but shall be used with caution and avoided when possible. Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable. e.g., for the above case, by heating the outside air sensor with a hair blower rather than overwriting the value or by altering the appropriate set point to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.
  - 4. Simulated Signals: Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overwritten values.



5. Altering Set points: Rather than overwriting sensor values, and when simulating conditions is difficult, altering set points to test a sequence is acceptable. For example, to see the AC compressor lockout work at an outside air temperature below 55°F, when the outside air temperature is above 55°F, temporarily change the lockout set point to be 2°F above the current outside air temperature.
  6. Indirect Indicators: Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the control system represent actual conditions and responses. Much of this verification is completed during pre-functional testing.
  7. Set-up: Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Sub executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Sub shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.
  8. Sampling: Sampling shall not be permitted on this project. All modified equipment and new systems shall be tested in their entirety.
- F. Coordination and Scheduling: The Subs shall provide two (2) week notice to the CxA regarding their completion schedule for the pre-functional checklists and startup of all equipment and systems. The CxA will schedule functional tests through the OPM and CC. The CxA shall direct, witness and document the functional testing of all equipment and systems. The Subs shall execute the tests.
- G. In general, functional testing is conducted after pre-functional testing and startup has been satisfactorily completed. The control system shall be sufficiently tested and approved by the CC before it is used for TAB or to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is checked.
- H. Test Equipment: Refer to Section 01 91 10, Part 2 for test equipment requirements.
- I. Problem Solving: The CxA will recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the CC, Subs and O/E.

### 3.7 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

- A. Documentation: The CxA shall witness and document the results of all functional performance tests using the specific procedural forms developed for that purpose. Prior to testing, these forms are provided to the OPM for review and approval and to the Subs for review. The CxA will include the filled out forms in the O&M manuals.
- B. Non-Conformance:
  - 1. The CxA will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported to the OPM on the Commissioning Issues Log.
  - 2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form.
  - 3. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the OPM.
  - 4. As tests progress and a deficiency is identified, the CxA discusses the issue with the executing contractor.
    - a. When there is no dispute on the deficiency and the Sub accepts responsibility to correct it:
      - 1) The CxA documents the deficiency and the Sub's response and intentions and they go on to another test or sequence. After the day's work, the CxA reports the deficiency on the Commissioning Issues Log to the OPM. A copy is provided to the CC and Sub. The Sub corrects the deficiency, signs a statement of correction certifying that the equipment is ready to be retested and sends it back to the CxA.
      - 2) The CxA reschedules the test and the test is repeated.
    - b. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:
      - 1) The deficiency shall be documented on Commissioning Issues Log with the Sub's response and a copy given to the OPM and to the Sub representative assumed to be responsible.
      - 2) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as

needed. Final interpretive authority is with the CxA. Final acceptance authority is with the Project Manager.

- 3) The CxA documents the resolution process.
  - 4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CxA. The CxA reschedules the test and the test is repeated until satisfactory performance is achieved.
5. Cost of Retesting
- a. The cost for the Sub to retest a pre-functional or functional test, if they are responsible for the deficiency, shall be theirs. If they are not responsible, any cost recovery for retesting costs shall be negotiated with the CC.
  - b. For a deficiency identified, not related to any pre-functional checklist or startup fault, the following shall apply: The CxA and OPM will direct the retesting of the equipment once for a total of 8 hours maximum at no “charge” to the CC for their time. However, the CxA’s and OPM’s time for a second retest or for retesting exceeding 8 hours will be charged to the CC, who may choose to recover costs from the responsible Sub.
  - c. The time for the CxA and OPM to direct any retesting required because a specific pre-functional checklist or startup test item, reported to have been successfully completed, but determined during functional testing to be faulty, will be back charged to the CC, who may choose to recover costs from the party responsible for executing the faulty pre-functional test.
6. The Contractor shall respond in writing to the CxA and OPM at least as often as commissioning meetings are being scheduled concerning the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.
7. Any required retesting by any contractor shall not be considered a justified reason for a claim of delay or for a time extension by the General Contractor (CC).
- C. Failure Due to Manufacturer Defect: If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the OPM. In such case, the Contractor shall provide the Owner with the following:

1. Within one week of notification from the OPM, the Contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the OPM within two weeks of the original notice.
  2. Within two weeks of the original notification, the Contractor or manufacturer shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
  3. The OPM will determine whether a replacement of all identical units or a repair is acceptable.
  4. Two examples of the proposed solution will be installed by the Contractor and the PM will be allowed to test the installations for up to one week, upon which the OPM will decide whether to accept the solution.
  5. Upon acceptance, the Contractor and/or manufacturer shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.
- D. Approval: The CxA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the CxA and by the OPM, if necessary. The CxA recommends acceptance of each test to the OPM using a standard form. The OPM gives final approval on each test using the same form, providing a signed copy to the CxA and the Contractor.

### 3.8 OPERATION AND MAINTENANCE MANUALS

#### A. Standard O&M Manuals

1. Initial Submittal: Submit four (4) Draft Copies of each manual no later than 150 days prior to substantial completion. Include a complete Operation and Maintenance directory. The Project Manager will return one (1) copy and mark whether general scope and content of manuals are acceptable.
2. Final Submittal: Submit six (6) copies of each manual in final format at least one hundred twenty (120) days prior to substantial completion. The OPM will return one (1) copy with O/E comments within fourteen (14) days. Correct or modify each manual to comply with the comments made. Submit six (6) copies of each corrected manual within fourteen (14) days of receipt of O/E comments.
3. The specific content and format requirements for the standard O&M manuals are detailed in Section 01 33 00 and the LCPS requirements.

Special requirements for the controls contractor and TAB contractor are found in Section 23 08 00, Part 3.

4. O/E Contribution: The O/E will include in the beginning of the O&M manuals a separate section describing the systems including:
  - a. The design intent narrative prepared by the O/E and provided as part of the bid documents, updated to as-built status by the O/E.
  - b. Simplified professionally drawn single line system diagrams on 8 ½" x 11" or 11" x 17" sheets. These shall include chillers, water system, condenser water system, heating system, supply air systems, exhaust systems and heaters. These shall show major pieces of equipment such as pumps, chillers, boilers, control valves, expansion tanks, coils, service valves, etc.
5. CxA Review and Approval: The CxA shall review the O&M manuals, documentation and redline as-builds for systems that were commissioned and other systems documentation that the CxA should review, to verify compliance with the Specifications. The CxA will communicate deficiencies in the manuals to the OPM or O/E, as requested. Upon a successful review of the corrections, the CxA recommends approval and acceptance of these sections of the O&M manuals to the OPM or O/E. The CxA also reviews each equipment warranty and verifies that all requirements to keep the warranty valid are clearly stated. This work does not supersede the O/E's review of the O&M manuals according to the O/E's contract.

### 3.9 TRAINING OF OWNER PERSONNEL

- A. The CC shall be responsible for training coordination and scheduling and ultimately for ensuring that training is completed.
- B. The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment.
  1. The CC shall interview the facility manager and lead engineer to determine the special needs and areas where training will be most valuable. The Owner and CxA shall decide how rigorous the training should be for each piece of commissioned equipment. The CxA shall communicate the results to the Subs and vendors who have training responsibilities.
  2. In addition to these general requirements, the specific training requirements of Owner personnel by Subs and vendors is specified in Division 23 and 26 and other sections where training requirements are found.
  3. Each Sub and vendor responsible for training will submit a written training plan to the CxA for review and approval prior to training. The plan will cover the following elements:

- a. Equipment (included in training)
  - b. Intended audience
  - c. Location of training
  - d. Objectives
  - e. Subjects covered (description, duration of discussion, special methods, etc.)
  - f. Duration of training on each subject
  - g. Instructor for each subject
  - h. Methods (classroom lecture, video, site walk-through, actual operational demonstrations, written handouts, etc.)
  - i. Instructor and qualifications
  - j. A sign in sheet shall be provided for each training session and shall be furnished to the owner with the final O&M Manuals.
  - k. A survey of training participants shall be included for each training session.
4. For the primary HVAC equipment, the Controls Contractor shall provide a short discussion of the control of the equipment during the mechanical or electrical training conducted by others.
  5. The CxA reviews the overall training plan and coordinates and schedules, with the OPM and CC, the overall training for the commissioned systems. The CxA develops criteria for determining that the training was satisfactorily completed, including attending some of the training, etc. The CxA recommends approval of the training to the CA using a standard form. The OPM also signs the approval form.
  6. Video taping of all training sessions will be provided by the CC with CD's cataloged by CC, and added to the O&M manuals.
  7. The mechanical design engineer shall at the first training session present the overall system design concept and the design concept of each equipment section. This presentation shall include a review of all systems using the simplified system schematics (one-line drawings) including chilled water systems, condenser water or heat rejection systems, heating systems, supply air systems, exhaust system and outside air strategies.

### 3.10 DEFERRED TESTING

- A. Unforeseen Deferred Tests: If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the OPM. These tests will be conducted in the same manner as the seasonal tests as soon as possible. Services of necessary parties will be negotiated.

END OF SECTION 019110

## SECTION 230100 - BASIC HVAC REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 CONTRACT DOCUMENTS

- A. Unless otherwise modified, provisions of General Conditions, Supplementary Conditions and Division-01 govern work under the Mechanical Divisions.
- B. Contract drawings for mechanical work are diagrammatic, intended to convey scope and general arrangement. Contractor shall review and coordinate routing of new work to clear existing piping, duct, electrical, structure, etc. at no cost to the Owner. All dimensions of existing conditions shall be considered approximate (for information only). All dimensions shall be verified prior to construction.
- C. Contract Document Interpretation/Discrepancies:
  - 1. Should the Contractor discover any discrepancies or omissions on the drawings or in the specifications, he shall notify the Engineer of such conditions prior to the bid date. Otherwise, it will be understood that the drawings and specifications are clear as to what is intended and shall be as interpreted by the Engineer.
  - 2. In addition, should any contradiction, ambiguity, inconsistency, discrepancy or conflict appear in or between any of the Contract Documents, the Contractor, shall, before proceeding with the work in question, notify the engineer and request an interpretation. In no case shall he proceed with the affected work until advised by the engineer.
  - 3. If the Contractor fails to make a request for interpretation of discrepancies or conflicts in the drawings or specifications, no excuse will be accepted for failure to carry out the work in a satisfactory manner, as interpreted by the engineer. In all cases, the Contractor will be deemed to have estimated the most stringent materials and methods (i.e. the highest quality materials and most expensive manner of completing the work) unless he has requested and obtained written authorization as to which methods or materials will be required.
  - 4. Each and every trade or subcontractor will be deemed to have familiarized himself with all drawings of this project, including Mechanical, Electrical, Plumbing etc. so as to avoid coordination errors, omissions, and misinterpretations. No additional compensation will be authorized for alleged errors, omissions, and misinterpretation, whether they are a result of failure to observe these requirements or not.
- D. The complete set of Mechanical and Electrical, drawings, specifications, and addenda apply to this work.



## 1.2 SCOPE

- A. The work in Division-23 includes furnishing and installing the mechanical systems complete and ready for satisfactory service.
- B. Requirements specified govern work in all sections of Division-23.

## 1.3 REFERENCES

- A. References to standards, codes, catalogs and recommendations are latest edition in effect on date of invitation to bid.
- B. Refer to applicable contract drawings, specifications and addenda pertaining to other divisions for conditions affecting work.
- C. Refer to Division-01 for description of alternates.
- D. Refer to Division-01 for description of base bid items.
- E. Refer to Division-01 for description of demolition items.

## 1.4 DEFINITIONS

- A. Following are definitions of terms and expressions used in this Division:
  - 1. "Approve" - to permit use of material, equipment or methods conditional upon compliance with contract document requirements.
  - 2. "Concealed" - hidden from normal sight; includes work in crawl spaces, above ceilings, and in building shafts.
  - 3. "Directed" - directed by Engineer.
  - 4. "Ductwork" - includes ducts, fittings, housings, dampers, supports and accessories comprising a system.
  - 5. "Equal, equivalent" - possessing the same performance qualities and characteristics and fulfilling the same utilitarian function.
  - 6. "Exposed" - not concealed.
  - 7. "Indicated" - indicated in Contract Documents.
  - 8. "Piping" - includes pipe, fittings, valves, supports and accessories comprising a system.
  - 9. "Provide" - furnish and install.
  - 10. "Removable" - detachable from the structure or system without physical alteration of materials or equipment or disturbance to other construction.

11. "Review" - limited observation or checking to ascertain general conformance with design concepts and general compliance with contract document requirements. Such action does not constitute a waiver or alteration of the contract requirements. Verification of quantities and dimensions shall be the responsibility of the Contractor.
12. "Appurtenances" - a device or assembly installed in the referenced system which performs some useful referenced function in the operation, maintenance, servicing, economy or safety of the system. Some examples include, but are not limited to aerators, anchors, supports, gauges, backflow preventers, expansion tanks, filters, flow controls, heat exchangers, interceptors, meters, pressure reducing valves, relief valves, dampers, separators and similar devices.
13. "Record Documents" - drawings, plans and specifications that indicate the nature and location of work reported by Contractors, but not verified by Consultant. Record documents cannot be considered reliable; as they are based on information reported by the Contractor only and is not verified by the Architect or Engineer (A/E).

#### 1.5 MATERIAL, EQUIPMENT AND SUBSTITUTION REQUIREMENTS

- A. Use products of one manufacturer where two or more items of same kind of equipment are required.
- B. Materials and equipment shall have a record of two (2) years successful field use.
- C. Nameplate: For each piece of power operated mechanical equipment provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.
- D. Where items of equipment are indicated as Base Bid on the bid form include in the Bid price the cost of providing the equipment upon which the specification is based. In addition, submit with bid for Owner's consideration the amount to be added or deducted from the base bid for other listed manufacturers' equipment. Owner will advise Contractor within forty-five (45) days after award of contract of his selection.

#### 1.6 MATERIAL AND EQUIPMENT LIST

- A. Within thirty (30) days after award of the contract, submit for Engineer's review a list of subcontractors' and manufacturers' names for items proposed for this project.

#### 1.7 SUBMITTALS

- A. Where the drawings and/or specifications indicate more than one allowable manufacturer for a particular piece of equipment and/or product, only those manufacturers indicated may submit products and services to be included in the

work. Unless otherwise indicated, manufacturers other than those listed will not be acceptable.

- B. Submit shop drawings, manufacturer's data and certificates for equipment, materials and finish, and pertinent details for each system where specified in each individual section, and obtain approval before procurement, fabrication, or delivery of the items to the job site. Partial submittals are not acceptable and will be returned without review.
- C. Shop Drawings: Drawings shall include floor plans, sectional views, wiring diagrams, and installation details of equipment. Include equipment spaces identifying and indicating proposed location, layout and arrangement of items of equipment, control panels, accessories, piping, ductwork, and other items that must be shown to assure a coordinated installation. Wiring diagrams shall identify circuit terminals, and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. If equipment is disapproved, drawings shall be revised to show acceptable equipment and be resubmitted. All equipment and/or products shall be submitted by an authorized factory representative of that particular product.
- D. Manufacturer's Data: Submittals for each manufactured item shall be manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog cuts.
- E. Standards Compliance: When materials or equipment must conform to the standards of organizations such as the American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), American Society of Mechanical Engineers (ASME), American Gas Association (AGA), American Refrigeration Institute (ARI), and Underwriters' Laboratories (UL), proof of such conformance shall be submitted to the Engineer for review. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified in the individual sections. In lieu of the label or listing, the Contractor shall submit a certificate from an independent testing organization, which is competent to perform acceptable testing. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard. For materials and equipment whose compliance with organizational standards or specifications is not regulated by an organization using its own listing or label as proof of compliance, a certificate of compliance from the manufacturer shall be submitted for review. The certificate shall identify the manufacturer, the product, and the referenced standard and shall simply state that the manufacturer certifies that the product conforms to all requirements of the project specification and of the referenced standards listed.
- F. Contractor shall thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission and coordinate installation requirements for equipment submitted, including, a) the verification of equipment weights relative to the existing and/or new structural support system and b) the

verification of equipment dimensions relative to existing and/or new architectural conditions. Contractor shall be responsible for correctness of all submittals.

- G. Submittals will be checked only for general conformance with the design concept and are subject to the original contract documents, as well as any corrections and comments noted. Comments noted, if any, will not be considered a complete list of all omissions, deviations and corrections necessary to meet the requirements of the contract documents. The Contractor will be responsible to confirm that the final product and installation will be in conformance with the contract documents in their entirety, including the responsibility to fully coordinate all work with other trades and to confirm the correctness of dimensions, quantities, and capacities. Submittal review does not authorize or constitute a change to the contract requirements and does not release the Contractor of responsibility to conform to the contract requirements. Requirements of the contract are not waived by review of any and all substitutions. The Contractor must fulfill the terms of the contract.
- H. Compliance Review Form: Each equipment submittal must include a Compliance Review Form formatted as follows:
  - 1. Section 1: Certify that the submittal is in complete compliance with the plans and specifications, except for the numbered and footnoted deviations and exceptions as defined herein. Deviations or exceptions taken in a cover letter or by contradiction or omission shall not constitute a release from the requirement that the equipment be in complete compliance with the plans and specifications.
  - 2. Section 2: Provide a detailed paragraph by paragraph annotation of the specification with an individual “C”, “D”, or “E” noted in the margin, as follows:
    - a. “C” shall mean compliance with no exceptions. Provide a numbered footnote (i.e. C1, C2, C3, etc.) for each comment or clarification.
    - b. “D” shall mean compliance with deviations. For each deviation, provide a numbered footnote (i.e. D1, D2, D3, etc.) with a detailed explanation of how the intent of this specification is to be satisfied.
    - c. “E” shall mean exception. The equipment offered is not in compliance with the specifications. For each exception, provide a numbered footnote (i.e. E1, E2, E3, etc.) with a detailed description of the exception.
- I. Electronic Submittals: Should the Contractor elect to submit electronic shop drawings/submittals, the procedure shall be as follows:
  - 1. Provide a transmittal with the electronic shop drawing/submittal indicating that the document was transmitted electronically. Transmittal shall also include verification of the Contractor’s review indicating compliance with the contract documents in accordance with paragraph 1.7. F of this section.

2. Sequentially number all pages on the electronic shop drawing/submittal. The total number of pages shall be reflected in the transmittal.
  3. Submittal review comments shall be transmitted electronically. Large documents will be scanned with comments as necessary and returned electronically.
  4. All shop drawings such as, but not limited to: coordination drawings, ductwork shop drawings, fire alarm drawings, ductbank layouts, etc. shall be submitted in hard copy, full size format.
  5. Provide hard copy of the shop drawing/submittal for each of the Operations and Maintenance Manuals.
  6. Failure to comply with the above will result in the submittal being returned and marked "Not Reviewed".
- J. Submittals will be reviewed for general compliance with design concept in accordance with contract documents. Dimensions, quantities, weights, or other details will not be verified by the A/E; this is the responsibility of the Contractor.
- K. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted.
- L. Review Period: BKM shall be allotted two (2) weeks for the processing, review and return of all submittals. It shall be incumbent upon the Contractor to include this time period in their schedule.
1. Resubmittals: BKM shall be allotted an additional two weeks (14 days) for the review of each resubmittal. Again, it shall be the Contractor's responsibility to submit the appropriate materials in a timely fashion.
  2. Contract Extension: No extension in contract time will be authorized as a result of the timeline addressed above.
- M. Submittal Identifications:
1. Place a permanent label or title block on each submittal for identification.
  2. Indicate name of firm or entity that prepared each submittal on label or title block.
  3. Provide a space approximately 4 by 5 inches on label or beside title block to record Contractor's review and approval markings and action taken by A/E.
  4. Include the following information on label for processing and recording action taken:
    - a. Project name

- b. Date
  - c. Name and address of A/E
  - d. Name and address of Contractor
  - e. Name and address of subcontractor
  - f. Name and address of supplier
  - g. Name of manufacturer
  - h. Unique identifier, including revision number
  - i. Number and title of appropriate specification section
  - j. Drawing number and detail references, as appropriate
  - k. Other necessary identification
  - l. Example: 230700-01-0
    - 1) 230700 references the spec section
    - 2) 01 indicates this is the first submittal from this spec section
    - 3) 0 indicates this is the original submittal (where 1 would indicate this is the first re-submittal)
- N. The Engineer will provide a maximum of two (2) submittal reviews per equipment submittal; the initial review plus one (1) re-submittal. Should the re-submittal be returned “Not Acceptable” or “Revise and Resubmit”, the Contractor shall choose one of the following courses of action:
- 1. Provide the exact manufacturer and model indicated in the contract documents as the basis of design, or
  - 2. Reimburse the Engineer for all additional review time required to achieve a submittal review from the Engineer of “No Exceptions Taken.”
  - 3. Should the Contractor choose option 2 above, the Engineer shall be reimbursed at an hourly rate of \$175 per hour with payment due prior to the return of the final submittal. In addition, the Contractor shall accept complete responsibility for all delays resulting from the submittal review process extending beyond two (2) reviews per equipment submittal.
- O. Resubmittals: Resubmittals shall comply with paragraph 1.7 of this section and the following additional requirements.

1. Resubmittals shall include a written response to each submittal comment. Provide a detailed comment by comment annotation of the submittal review comments with an individual “C”, “D”, or “E” as follows:
  - a. “C” shall mean compliance with no exceptions. Provide a numbered footnote (i.e. C1, C2, C3, etc.) for each comment or clarification.
  - b. “D” shall mean compliance with deviations. For each deviation, provide a numbered footnote (i.e. D1, D2, D3, etc.) with a detailed explanation of how the intent of this specification is to be satisfied.
  - c. “E” shall mean exception. The equipment offered is not in compliance with the specifications. For each exception, provide a numbered footnote (i.e. E1, E2, E3, etc.) with a detailed description of the exception.

#### 1.8 MANUFACTURER'S RECOMMENDATIONS

- A. Installation procedures are required to be in accordance with the recommendations of the manufacturer of the material being installed.

#### 1.9 ACCESSIBILITY

- A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.

#### 1.10 SAFETY REQUIREMENTS

- A. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts located so that any person can come in close proximity thereto shall be fully enclosed or properly guarded in accordance with OSHA. High-temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be properly guarded or covered with insulation of a type as specified herein. Items such as catwalks, ladders, and guardrails shall be provided where required for safe operation and maintenance of equipment.

#### 1.11 WORKMANSHIP

- A. Remove and replace, at no extra cost, all work not orderly, reasonably neat, or workmanlike.
- B. Coordinate all work and cooperate with other trades to facilitate execution of work.

1.12 SITE EXAMINATION/EXISTING CONDITIONS VERIFICATION

- A. Failure to visit site and become familiar with existing conditions prior to bidding will not relieve the Contractor of responsibility for complying with the Contract documents.
- B. Contractor shall field verify existing services and direction of flow of piping and ductwork prior to connection. Existing mechanical identification shall not constitute proper verification of service or direction of flow.

1.13 REGULATIONS AND CODES

- A. Comply with all applicable codes and regulations.
- B. All equipment provided shall be in accordance with all applicable local, state, and federal codes, guidelines and standards, as well as the authority having jurisdiction. Equipment and installation shall be in compliance with all applicable energy codes including the most current version of ASHRAE Standard 90.1.

1.14 CLEANING UP

- A. Keep premises free from accumulation of debris.
- B. Remove tools, scaffolding, surplus material, debris, and leave premises broom clean.
- C. On discontinuance of part of the work, place all debris in containers and promptly remove them from the Owner's property.
- D. Leave all areas broom clean.
- E. Final clean-up shall be performed.

1.15 PROTECTION

- A. Protect mechanical and electrical material and equipment from the elements or other injury as soon as delivered on premises.
- B. Cap or plug openings in equipment, piping, duct, and conduit systems to exclude dirt and other foreign material. Rags, wool, cotton, paper, waste or similar materials shall not be used for plugging.
- C. Unless approved by Owner, HVAC equipment shall not be used for temporary heating or ventilation during construction.
- D. Contractor shall protect all existing mechanical, electrical and architectural equipment, materials, finishes, etc. located within or adjacent to the work environment. Contractor shall be responsible for restoration of all existing mechanical, electrical and architectural items to remain. All equipment to remain



must be restored to its pre-existing condition prior to the start of work. Restoration and/or replacement shall be at no cost to the Owner.

- E. Contractor shall provide temporary cooling and heating as required to protect all construction materials from the potential adverse effects of high or low temperature and humidity. Upon delivery of ceiling and other finish materials to a location within the building, environmental conditions in all spaces where the materials will be either stored or installed shall be permanently maintained at 75°F (+2°F) and 50% RH (+5%). Should the HVAC include a reheat system, the reheat system shall be energized to provide temperature and humidity control whenever the HVAC system is energized. Contractor shall pay for all utility, fuel, operational, maintenance and repair costs associated with providing the environmental conditions indicated above until the Owner accepts occupancy of the building.

#### 1.16 FUNCTIONAL PERFORMANCE TESTING AND VERIFICATION

- A. General: The Contractor shall perform functional performance tests to verify that all systems are designed, installed, calibrated and adjusted to perform as required in the Contract.
- B. Comply with all applicable specification sections including, but not be limited to, “Basic HVAC Requirements”, “Testing, Adjusting and Balancing”, “Automatic Temperature Controls” and “Commissioning”, where applicable.
- C. Prior to functional performance testing, all indicating, recording and control devices shall be calibrated. A verification calibration report shall be provided with the final test report.
- D. Provide functional performance testing to verify proper operation of each and every control sequence indicated throughout the contract documents.
- E. Failure of Tests: Should any test, verification, or demonstration fail to meet the specification requirements, the component of the system causing the failure shall be repaired, replaced or readjusted. The failed test, verification, or demonstration shall then be repeated.
- F. Test Report: Upon satisfactory verification of calibration and functional performance tests, a copy of the final test results shall be bound in the operations and maintenance manual. The final report shall also include a full compliance statement, on company letterhead, indicating that all systems are installed and functioning per the contract requirements including drawings, specifications, control sequences and accepted submittals.
- G. The mechanical systems shall not be considered complete until all functional performance verification forms, calibration reports and compliance statement have been submitted and reviewed. Submit in accordance with the submittal requirements indicated elsewhere in these specifications.

## 1.17 OPERATING AND MAINTENANCE MANUAL

A. Submit Operation and Maintenance Manuals as follows:

1. Provide an electronic version for review by the Owner and A/E, including bookmarks of all section and subsections.
2. After acceptance of the electronic copy, produce hard copies in three-ring binders with each section separated by tab divider. Include protective plastic sleeves for any software or folded large documents submitted. Provide a minimum of two (2) copies to the Owner.

B. At a minimum, the manual shall contain the following:

1. Title page
2. Table of contents
3. Contractor and sub-contractor contact information
4. Supplier contact information for all mechanical equipment
5. Copies of manufacturer's and Contractor's warranty information (project and equipment) for all mechanical equipment.
6. Submittal log for all mechanical equipment
7. One (1) reviewed copy of each shop drawing or submittal incorporating all A/E and Owner submittal review comments.
8. Copy of inspector acceptance certificates / documents.
9. Provide an 11 x 17 fold-out drawing of each floor plan and indicate locations of the following:
  - a. System shutoff valves
  - b. Fire/smoke dampers
10. All duct, pipe and equipment pressure test reports complete with 11 x 17 fold-out drawing, indicating all systems tested.
11. Final Test and Balance (TAB) Reports. Do not include reports that have not been accepted by the A/E. Pencil or partial copies will not be acceptable.
12. Maintenance procedures for each item of mechanical equipment to include frequency and type of maintenance, spare parts and attic/stock list. This shall include the manufacturer's literature indicating operating and maintenance instructions, parts list, illustrations and diagrams.

13. An itemized list of all spare parts and specialty tools shall be transmitted to the Owner.
14. A report of the training procedures and content provided as well as the attendance log.
15. Valve tag chart
16. Mechanical systems functional performance verification forms, calibration reports and compliance statement indicating that all systems are installed and functioning per the contract requirements.

#### 1.18 TOOLS AND LUBRICANTS

- A. Furnish and turn over to the Owner, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.
- C. Tool Containers: Hardwood or metal, permanently identified for intended service and mounted, or located, where directed by the Owner.
- D. Lubricants: A minimum of one quart (.9 L) of oil, and one pound (450 g) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

#### 1.19 FIELD INSTRUCTION

- A. Upon completion of work, instruct Owner's representative in the proper operation and maintenance of the mechanical and electrical systems.
- B. Instruction periods specified below shall be in addition to instruction specified for certain items elsewhere in the specifications.
- C. Instructions shall be given by persons expert in the following systems and equipment and shall include descriptions and demonstration of procedures, data logging, and analysis.
  1. Automatic Control - Including operating controls for all heating, cooling, ventilating systems, control centers, panels, compressed air system. Provide **five (5) days** of instruction.
  2. General Instructions - Including review of written operating instructions and balancing report, miscellaneous instructions. Provide **five (5) days** of instruction.
- D. Instructions shall be given by persons expert in the operation and maintenance and shall be for a period of not less than . . . eight hour days.

- E. Prepare statement(s) for signing by Owner's representative indicating date of completion of instructions and hours expended. Furnish copy of signed statement to Engineer.
- F. Final mechanical demonstration of all mechanical equipment shall be recorded in DVD compatible format. Provide DVDs to the Owner.

#### 1.20 RECORD DOCUMENTS

- A. The Contractor shall maintain a record set of mechanical prints at the project site and shall indicate thereon any changes made to the contract drawings, including, but not limited to addenda, field sketches, RFI responses, supplemental drawings, sketches, etc. Where changes are made that are reflective of supplemental instructions, revisions, RFI responses, etc., the Contractor shall make clear references to those changes.
- B. A separate set of neat, legible mechanical contract prints shall be kept at the project site at all times during the construction of the work for the express purpose of showing any and all changes indicated in paragraph A. above. The prints shall be marked up daily showing all changes to the original documents. The prints shall be marked up in a neat, legible manner using a red pen. Periodic review of the Record Documents will be conducted by the Owner's Representative or A/E. Should this review indicate that the Record Documents are deficient or not up to date, the Contractor shall immediately bring the documents into compliance and make the corrections.
- C. Upon completion of the project and before final close-out, the Contractor shall be responsible for producing a final set of record documents in the same electronic format as the construction documents (i.e. AutoCad or Revit). One (1) set of full size prints, one (1) CD of the electronic files, along with the red-lined marked up field set shall be delivered to the Owner upon completion. If requested, the electronic files shall be uploaded to the Owner's FTP site. The final documents shall indicate in the title or revision block "RECORD DOCUMENTS" along with the date completed. The electronic format shall be compatible with the Owner's preferred version of AutoCad or Revit. Coordinate with the Owner before producing the CD or uploading to the FTP site. Not acceptable are Contractor installation drawings, shop drawings or multi-layers of work on a single drawing. The final as-built product shall mirror the contract bid documents using the project page layout, format and project title block.
- D. Electronic files (AutoCad or Revit) of mechanical, electrical, plumbing and fire protection (MEP) drawings may be made available upon receipt of a signed copy of the Engineer's Electronic Document Disclaimer (available upon request).
- E. Should the Contractor's electronic Record Documents not be considered complete, they will be returned for completion and/or correction.

## 1.21 DEMOLITION

- A. All demolition of existing mechanical and electrical piping, auxiliaries and equipment, shall be as specified under the "Demolition" section, of these specifications, as shown on the drawings, and as required to complete the new and renovated installations and shall be performed by the respective mechanical and electrical contractors.
- B. This work shall include the disconnection and capping of existing services, and the removal of existing piping, wiring, fittings, equipment, including heat transfer units, air handling units, fans, electrical controls and panelboxes, ductwork, etc., not reused in the new work or required to complete the renovation work. Contractor shall note the drawings specify certain existing equipment to be reused.
- C. Any removed items requested by the Owner shall remain the property of the Owner. Contractor shall remove equipment and store on site as directed by the Owner. All other equipment or material shall become the property of the Contractor and shall be removed from the site. Contractor shall meet Federal EPA Laws, Regulations and Guidelines in regard to removal of asbestos insulation.
- D. The Contractor shall use care when performing selective building and site demolition. The Contractor shall be responsible for damage inclusive of but not limited to: building finishes, lighting (interior and exterior), furniture, structure, site, utilities (above and below ground), mechanical, plumbing, telecommunications and electrical equipment / systems. Should any damage occur or should any remedial work be required, the Contractor shall be responsible to repair and or replace the damaged item(s) to the Owner's satisfaction at no additional cost. The Contractor shall be responsible for surveying (including contacting Miss Utility), photo documenting and restoring the surrounding work site(s) to the original pre-demolition condition and / or to the Owner's satisfaction upon completion of the work at no additional cost.

## 1.22 OUTAGES

- A. All mechanical 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 Owner's Representative.
- 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 (10) days in advance with the Owner's Representative. All such outages shall be performed during other than normal duty hours.
- C. 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 the convenience of the using agency.

1.23 GUARANTEE/WARRANTY

- A. Each Contractor shall furnish a guarantee covering all labor and materials furnished by him for a period of two (2) years from the date of final acceptance of his work, and he shall agree to repair and make good at his own expense any and all defects which may appear in his work during that time if, in the judgment of the Engineer, such defects arise from defective workmanship and/or imperfect or inferior material.
- B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of guarantee shall be delivered to the Owner.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION 230100



## SECTION 230200 - PROJECT CLOSEOUT HVAC

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This section provides a summary of the primary mechanical project closeout activities, however, this section does not attempt to address all project closeout requirements. Closeout activities referenced in this section include the following:
  - 1. Start-up
  - 2. Punch-out Procedures
  - 3. Testing, Adjusting and Balancing
  - 4. Functional Performance Testing and Verification
  - 5. Operation and Maintenance Manuals (O & M Manuals)
  - 6. Demonstration and Training
  - 7. Record Documents
  - 8. Close-out Documents
- B. This Section shall not supersede any other close-out section or requirements of the Contract. Refer to other Divisions of the specifications and the General Requirements of the Contract for further instructions.

### PART 2 - PRODUCTS

Not Applicable

### PART 3 - EXECUTION

#### 3.1 START-UP

- A. The Contractor shall perform start-up on each piece of mechanical equipment as specified in each section of Division-23.
- B. Where indicated in each section of Division-23, the services of a factory authorized and certified technician shall be required to perform the equipment start-up. Start-up by any other organization other than as required by the manufacturer is unacceptable.
- C. Start-up reports shall be provided for all equipment and be included in the final O & M Manuals.



### 3.2 PUNCH-OUT PROCEDURES

#### A. Preliminary Punch-out:

1. Prior to requesting an inspection from the Owner, Engineer, or Permit Official, the General Contractor or Construction Manager (GC or CM) shall provide a preliminary punch-out of the area in question.
2. Once completed, their punch list shall be supplied to each trade for corrections and completion. The punch list shall also be provided to the Engineer for their use.
3. Upon being informed that the trade contractors have addressed all of the outstanding items, the GC / CM shall backcheck the work and update the punch list.

#### B. Final Punch-out:

1. Final punch-out by the engineer shall not commence until the GC or CM has exhausted their review and has signed off on all items.
2. A copy of the sign-off shall be provided to the Engineer for their record.
3. Once the above has been completed, the Engineer shall be notified that the work is substantially complete and ready for a final punch-out.
4. Depending on the size, schedule, and project complexity, punch-outs may be requested for specific areas or systems, rather than the facility as a whole. Examples of specific requests include the following:
  - a. Above ceiling
  - b. Mock-ups for any repetitive installation to confirm acceptance prior to continuing (labs, dorms, offices, etc.)
  - c. Equipment rooms

- #### C.
- Upon completion of any and all punch lists (i.e. above ceiling, final, partial, phased, factory review, or specific item) the contractor shall provide an item by item sign-off indicating the date and who completed the item. The sign-off shall be submitted to the A/E and owner before final payment is processed. Should the contractor disagree with any item, they shall provide a written exception giving reason for review.

### 3.3 TESTING, ADJUSTING AND BALANCING

- #### A.
- Comply with all provisions of Division-23 Section, "Testing, Adjusting and Balancing" (TAB) for the systems listed, but not limited to, the following:

1. Building Automated Systems
  2. Fans
  3. Air Handling Units
  4. Ductwork Systems
  5. Pumps
  6. Chillers
  7. Cooling Towers
  8. Coils
  9. Piping Systems
  10. Terminal Units
  11. Heat Exchangers
- B. TAB reports shall be submitted as a separate project submittal for review. Upon review for general conformance, include the final TAB report in the O & M Manual.
- C. Comply with testing, adjusting and balancing requirements as indicated in each section within Division-23.

#### 3.4 FUNCTIONAL PERFORMANCE TESTING AND VERIFICATION

- A. General: In addition to the tests required during and after installation of all mechanical systems, as well as any other formal commissioning requirements, the Contractor shall perform functional performance tests to verify that all systems are designed, installed, calibrated and adjusted to perform as required in the Contract.
- B. Comply with all applicable specification sections including, but not be limited to, "Basic HVAC Requirements", "Testing, Adjusting and Balancing", "Automatic Temperature Controls" and "Commissioning", where applicable.
- C. Prior to functional performance testing, all indicating, recording and control devices shall be calibrated. A calibration verification report shall be provided with the final test report.
- D. Provide functional performance testing to verify proper operation of each and every control sequence indicated throughout the contract documents.
- E. Failure of Tests: Should any test, verification, or demonstration fail to meet the specification requirements, the component of the system causing the failure shall

be repaired, replaced or readjusted. The failed test, verification, or demonstration shall then be repeated.

- F. A "Functional Performance Test Verification Form" is included at the end of Section 230900. This form (electronic version is available upon request) shall be completed for all mechanical equipment provided under this contract. This shall include, but not be limited to each chiller, boiler, air handling unit, fan, pump, VAV terminal, fan coil unit, unit ventilator, DX cooling equipment, miscellaneous heating equipment, etc.
- G. Test Report: Upon satisfactory verification of calibration and functional performance tests, a copy of the final test results shall be bound in the operations and maintenance manual. The final report shall also include a full compliance statement, on company letterhead, indicating that all systems are installed and functioning per the contract requirements including drawings, specifications, control sequences and accepted submittals.
- H. The mechanical systems shall not be considered complete until all functional performance verification forms, calibration reports and compliance statement have been submitted and reviewed. Submit in accordance with the submittal requirements indicated elsewhere in these specifications.

### 3.5 OPERATION AND MAINTENANCE MANUALS

- A. Submit Operation and Maintenance Manuals as follows:
  - 1. Provide an electronic version for review by the Owner and A/E, including bookmarks of all section and subsections.
  - 2. After acceptance of the electronic copy, produce hard copies in three-ring binders with each section separated by tab divider. Include protective plastic sleeves for any software or folded large documents submitted. Provide a minimum of two (2) copies to the Owner.
- B. At a minimum, the manual shall contain the following:
  - 1. Title page
  - 2. Table of contents
  - 3. Contractor and sub-contractor contact information
  - 4. Supplier contact information for all mechanical equipment
  - 5. Copies of manufacturer's and contractor's warranty information (project and equipment) for all mechanical equipment.
  - 6. Submittal log for all mechanical equipment

7. One (1) reviewed copy of each shop drawing or submittal incorporating all A/E and owner submittal review comments.
8. Copy of inspector acceptance certificates / documents.
9. Provide an 11 x 17 fold-out drawing of each floor plan and indicate locations of the following:
  - a. System shutoff valves
  - b. Fire/smoke dampers
10. All duct, pipe and equipment pressure test reports complete with 11 x 17 fold-out drawing, indicating all systems tested.
11. Final Test and Balance (TAB) Reports. Do not include reports that have not been accepted by the A/E. Pencil or partial copies will not be acceptable.
12. Maintenance procedures for each item of mechanical equipment to include frequency and type of maintenance, spare parts and attic/stock list. This shall include the manufacturer's literature indicating operating and maintenance instructions, parts list, illustrations and diagrams.
13. An itemized list of all spare parts and specialty tools shall be transmitted to the Owner.
14. A report of the training procedures and content provided as well as the attendance log.
15. Valve tag chart
16. Mechanical systems functional performance verification forms, calibration reports and compliance statement indicating that all systems are installed and functioning per the contract requirements.

### 3.6 DEMONSTRATION AND TRAINING

- A. Upon completion of work, instruct the owner's representative in the proper operation and maintenance of each mechanical system in accordance with applicable specification sections.
- B. Instructions shall be given by persons expert in the operation and maintenance of each system / equipment.
- C. Prepare statement(s) for signing by Owner's representative indicating the date of completion of instructions and hours expended. Furnish copies of signed statements to the A/E.

- D. Final demonstration of all mechanical equipment shall be recorded in DVD compatible format.
1. The recordings shall be organized systemically from largest to smallest component.
  2. The recordings shall include bookmarks to reference each type of equipment, all major components, and each component requiring regular maintenance.
  3. No segment shall be unannotated longer than fifteen minutes.
  4. Submit a digital link of the draft for review by the owner and A/E.
  5. Submit two hardcopy DVDs of the final approved copy to the owner's representative.
  6. Submit a digital link of the final approved copy to the owner's representative.

### 3.7 RECORD DOCUMENTS

- A. The Contractor shall maintain a record set of mechanical prints at the project site and shall indicate thereon any changes made to the contract drawings, including, but not limited to addenda, field sketches, RFI responses, supplemental drawings, sketches, etc. Where changes are made that are reflective of supplemental instructions, revisions, RFI responses, etc., the Contractor shall make clear references to those changes.
- B. A separate set of neat, legible mechanical contract prints shall be kept at the project site at all times during the construction of the work for the express purpose of showing any and all changes indicated in paragraph A. above. The prints shall be marked up daily showing all changes to the original documents. The prints shall be marked up in a neat, legible manner using a red pen. Periodic review of the Record Documents will be conducted by the Owner's Representative or A/E. Should this review indicate that the Record Documents are deficient or not up to date, the Contractor shall immediately bring the documents into compliance and make the corrections
- C. Upon completion of the project and before final close-out, the Contractor shall be responsible for producing a final set of record documents in electronic CADD format. One (1) set of full size prints, one (1) CD of the electronic CADD drawings (in AutoCad and pdf format), along with the red-lined marked up field set shall be delivered to the owner upon completion. If requested, the electronic CADD documents shall be up-loaded to the owner's FTP site. The final CADD documents shall indicate in the title or revision block "RECORD DOCUMENTS" along with the date completed. The electronic format shall be compatible with the owner's preferred version of AutoCad. Coordinate with the owner before producing the CD or up-loading to the FTP site. Not acceptable are contractor installation drawings,

shop drawings or multi-layers of work on a single drawing. The final as-built product shall mirror the contract bid documents using the project page layout, format and project title block.

- D. Computer (CADD) files of mechanical drawings will be made available to the Contractor upon receipt of a signed waiver (available upon request). One CD will be made available to the general contractor or construction manager for distribution to the trades.
- E. Should the Contractor's electronic Record Documents not be considered complete, they will be returned for completion and/or correction.

### 3.8 CLOSEOUT DOCUMENTS

- A. Prior to Substantial Completion and /or Final Payment, the Contractor shall prepare and submit the following:
  - 1. Final punch lists indicating completion of all items
  - 2. All record drawings
  - 3. All record specifications
  - 4. Operation and Maintenance Manuals
  - 5. Complete final cleaning
  - 6. Remove temporary facilities and complete site restoration

END OF SECTION 230200



## SECTION 230500 - BASIC HVAC MATERIALS AND METHODS

### PART 1 - GENERAL

#### 1.1 CONTRACT DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification Sections, apply to this Section.
- B. Requirements specified in Division-23 Section "Basic HVAC Requirements" apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes limited scope general construction materials and methods for application with mechanical installations as follows:
  - 1. Mechanical equipment nameplate data.
  - 2. Firestopping: Provide seals for all openings (new and existing) through fire-rated walls, floors, or ceilings used as passage for mechanical and electrical components such as piping, ductwork, conduit, etc.
  - 3. Access panels and doors in walls, ceilings, and floors for access to mechanical materials and equipment.

#### 1.3 DEFINITIONS

- A. The following definitions apply to firestopping:
  - 1. Assembly: Particular arrangement of materials specific to given type of construction described or detailed in referenced documents.
  - 2. Barriers: Time rated fire walls, smoke barrier walls, time rated ceiling/floor assemblies and structural floors.
  - 3. Firestopping: Methods and materials applied in penetrations and unprotected openings to limit spread of heat, fire, gases and smoke.
  - 4. Penetration: Opening or foreign material passing through or into barrier or structural floor such that full thickness of rated materials is not obtained.
  - 5. Construction Gaps: Gaps between adjacent sections of walls, exterior walls, at wall tops between top of wall and ceiling, and structural floors or roof decks; and gaps between adjacent sections of structural floors.
  - 6. System: Specific products and applications classified and numbered by Underwriters Laboratories, Inc. to close specific barrier penetrations.



7. Sleeve: Metal fabrication or pipe section extending through thickness of barrier and used to permanently guard penetration. Sleeves are described as part of penetrating system in other sections and may or may not be required.

#### 1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division-01 Specification Sections.
- B. Product data for the following products:
  1. Access panels and doors
- C. Firestopping: Indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures.
  1. Provide details of each proposed assembly identifying intended products and applicable UL system number, or UL classified devices.
  2. Provide drawings relating to non-standard applications as needed.
- D. Coordination drawings for access panel and door locations in accordance with Division-23 sections.
- E. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an Installer for the installation and application of joint sealers, access panels and doors, and firestopping materials with at least two years' experience with installations.
- B. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.
  1. Provide UL Label on each fire-rated access door.
- C. Local and State Regulatory Requirements: Submit forms or acceptance for proposed assemblies not conforming to specific UL firestop system numbers, or UL classified devices.

#### 1.6 PROJECT CONDITIONS

- A. Conditions Affecting Selective Demolition: The following project conditions apply:

1. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
2. Locate, identify, and protect mechanical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

#### 1.7 SEQUENCE AND SCHEDULING

- A. Coordinate the shut-off and disconnection of utility services with the Owner and the utility company.
- B. Notify the Engineer at least five (5) days prior to commencing demolition operations.
- C. Perform demolition in phases as indicated.

### PART 2 - PRODUCTS

#### 2.1 MECHANICAL EQUIPMENT NAMEPLATE DATA

- A. Nameplate: For each piece of power operated mechanical equipment provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

#### 2.2 FIRESTOPPING

- A. All penetrations through fire barriers (new and existing) shall be firestopped with an approved material that is capable of maintaining the fire resistance rating of the barrier. All firestop sealants shall conform to ASTM E 814, ASTM E 119, UL 1479, UL 2079 CAN/ULC S115, and CAN/ULC S101.
- B. Firestop material shall be latex based, intumescent caulk intended for use for all thru-penetrations with piping, ducts, cable trays, conduit, and cables.
- C. When exposed to high temperatures or fires, the caulk shall expand in volume to quickly close off voids left by melting or burning construction materials. Caulk shall be applied by a standard caulk gun and remain flexible after curing.
- D. Acceptable products shall be limited to Johns Manville "Firetemp-C1;" Hilti "FS-One;" or 3M "CP25WB+." Coordinate with General Contractor such that a single manufacturer/ product is utilized throughout the project for all fire and smoke stopping materials.

## 2.3 SMOKE STOPPING

- A. All penetrations through smoke barriers, smoke partitions, or any other surface required to resist the passage of smoke (new and existing) shall be provided with a smoke stop sealant and/or system that has been independently tested to provide an acceptable smoke seal that will resist the passage of smoke. Smoke stop systems (including product and installation) shall conform to all applicable standards (including but not limited to ASTM, UL and NFPA), as well as all other local, state or federal requirements.
- B. Acceptable manufacturers shall be limited to the manufacturers that may provide firestopping materials/systems. Coordinate with the General Contractor such that a single manufacturer/product is utilized throughout the project for all fire and smoke stopping materials.

## 2.4 ACCESS DOORS

- A. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
- B. Frames: 16-gage (1.6 mm) steel, with a 1-inch (25 mm) wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
  - 1. For Installation in Masonry, Concrete, Ceramic Tile, or Wood Paneling: 1-inch (25 mm) wide exposed perimeter flange and adjustable metal masonry anchors.
  - 2. For Gypsum Wallboard or Plaster: Perforated flanges with wallboard bead.
  - 3. For Full-Bed Plaster Applications: Galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.
- C. Flush Panel Doors: 14-gage (2 mm) sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees (3.05 Radians); factory-applied prime paint.
  - 1. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
- D. Locking Devices: Flush, screwdriver-operated cam locks. [Common use]
- E. Locking Devices: Where indicated, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide two (2) keys. [Secured areas only: note as such].

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation and application of joint sealers and access panels. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 3.2 FIRESTOP INSTALLATION

- A. Install penetration seal materials in accordance with printed instructions of the UL Fire Resistance Directory and in accordance with manufacturer's instruction.
- B. Seal new and existing holes or voids made by penetrations to ensure an effective smoke barrier.
- C. Where floor openings without penetrating items are more than four inches (100 mm) in width and subject to traffic or loading, install firestopping materials capable of supporting same loading as floor.
- D. Protect materials from damage on surface subject to traffic.
- E. Place firestopping in annular space around fire dampers before installation of damper's anchoring flanges which are installed in accordance with fire damper manufacturer's recommendations.
- F. Where large openings are created in walls or floors to permit installation of pipes, ducts, cable tray, bus duct or other items, close unused portions of opening with firestopping material tested for the application.
- G. Install smoke stopping as specified for firestopping (new and existing).
- H. Where rated walls are constructed with horizontally continuous air space, double width masonry, or double stud frame construction, provide vertical, 12 inch (300 mm) wide fiber dams for full thickness and height of air cavity at maximum 15 foot (4500 mm) intervals.

### 3.3 SELECTIVE DEMOLITION

- A. General: Demolish, remove, demount, and disconnect abandoned mechanical materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- B. Materials and Equipment to be Salvaged: Remove, demount, and disconnect existing mechanical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

- C. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.
- D. Mechanical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
  - 1. Inactive and obsolete piping, fittings and specialties, equipment, ductwork, controls, fixtures, and insulation.
  - 2. Piping and ducts embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove materials above accessible ceilings. Drain and cap piping and ducts that are allowed to remain.
  - 3. Perform cutting and patching required for demolition in accordance with Division-1 Section "Cutting and Patching."

#### 3.4 INSTALLATION OF ACCESS DOORS

- A. Provide access doors (minimum 18" x 18") as required to provide maintainable access to all mechanical equipment including, but not limited to, valves, dampers, air terminals, etc.
- B. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- C. Adjust hardware and panels after installation for proper operation.

END OF SECTION 230500

## SECTION 230593 - TESTING, ADJUSTING AND BALANCING

### PART 1 - GENERAL

#### 1.1 DESCRIPTION OF WORK

- A. TAB contractor shall assist the ATC controls contractor to ensure all airflow, waterflow, static pressure setpoints, etc.. are transferred from the existing BAS system to the new BAS system. Where the information cannot directly be extracted from the existing BAS, the TAB contractor shall take manual readings.
- B. TAB contractor shall provide calibration of all sensors and devices as required for proper operation in the new BAS. Determine calibration factors.
- C. Pre-Demo Measurement, Testing and Report:
  - 1. Provide pre-demolition testing of all air-side equipment (AHU's to Air Terminals). Document airflow (max, min, and heating) and all other values required to accomplish the sequence of operations.
    - a. Air Terminals can be documented thru extraction information from the existing BAS. Direct measurement only required if information is unavailable.
    - b. Provide direct readings of all Air Handling Units, Heating and Ventilation Units, and Make-Up Air Units in addition to documenting the information in the existing BAS.
  - 2. Provide report for owner and engineer review and approval.
- D. Post-Installation Measurement, Testing and Report:
  - 1. Provide testing, adjusting and balancing of all air-side equipment (AHU's to Air Terminals) per the pre-demolition values.
  - 2. Provide testing, adjusting and balancing of all water-side equipment (pumps, coils, etc.) per the pre-demolition values and as required for operation of the systems under the new BAS.
- E. Extent of testing, adjusting, and balancing (TAB) work required by this section is indicated on drawings and schedules, and by requirements of this section, and is defined to include, but is not necessarily limited to, air distribution systems, hydronic distribution systems, and associated equipment and apparatus of mechanical work. The work consists of setting speed and volume (flow), adjusting facilities provided for systems, recording data, conducting tests, preparing and submitting reports to achieve the capacities or setpoints indicated on the contract documents, and recommending modifications to work as required to achieve the capacities or setpoints indicated on the contract documents.

- F. Component types of testing, adjusting, and balancing specified in this section shall include, but not be limited to, the following as applied to mechanical equipment:
1. Building automated systems
  2. Fans
  3. Air handling Units, Heating and Ventilation Units, Makeup Air Units, etc.
  4. Piping systems, components and coils
  5. Air Terminal Units (CAV, VAV, single-duct and fan-powered units)
  6. Air devices - EXCLUDED
  7. Air flow Measuring Stations

## 1.2 QUALITY ASSURANCE

- A. Tester's Qualifications: A firm certified by Associated Air Balance Council (AABC) who is not Installer of system to be tested.
1. AABC Compliance: Comply with the current AABC's Manual "AABC National Standards", as applicable to mechanical air and hydronic distribution systems, and associated equipment and apparatus.
  2. Industry Standards: Comply with AABC recommendations pertaining to measurements, instruments, and testing, adjusting, and balancing, except as otherwise indicated.
  3. ASHRAE Standard 111: Comply with current edition of ASHRAE 111, "Measurement, Testing, Adjusting and Balancing of HVAC Systems".
  4. Independence: TAB contractor shall be independently owned and operated with no affiliation with the general contractor, mechanical contractor, sheet metal contractor, design engineer, etc.
  5. Experience: Each technician shall demonstrate a minimum of three years of actual test and balance field experience.
- B. Pipe Testing Procedures: Contractor shall pressure test all piping systems in accordance with the following:
1. ASME Code for Pressure Piping B31, most current edition.
  2. National Fire Protection Association (NFPA), all applicable sections, most current edition.

### 1.3 SUBMITTALS

- A. Qualification: TAB contractor qualifications shall be provided as a formal submittal for review to demonstrate conformance with all qualifications indicated throughout the contract documents.
- B. Submit certified test reports, signed by the AABC Test and Balance technician who performed the TAB work. In addition, the report shall be certified by an AABC certified Test and Balance Engineer (T.B.E.) who is familiar with the project.
  - 1. Include identification and types of instruments used, and their most recent calibration date with submission of final test report.
  - 2. Provide Pre-Demolition Test Report
  - 3. Provide Post-Installation Test Report
- C. The Contractor shall maintain a copy of AABC standards on the site during all TAB work. Said document(s) shall be made available to Owner representatives for reference as to minimum requirements.
- D. Maintenance Data: Include in maintenance manuals, copies of certified test reports, identification of instruments.

### 1.4 JOB CONDITIONS

- A. Do not proceed with testing, adjusting, and balancing work until work has been completed, tested, operable, and all balancing devices indicated on the contract documents have been installed. Ensure that there is no residual work still to be completed on the equipment to be tested.
- B. Do not proceed until work scheduled for testing, adjusting, and balancing is clean and free from debris, dirt and discarded building materials.

## PART 2 - PRODUCTS

### 2.1 PATCHING MATERIALS

- A. Except as otherwise indicated, use same products as used by original Installer for patching holes in insulation, ductwork and housings which have been cut or drilled for test purposes, including access for test instruments, attaching jigs, and similar purposes.
  - 1. Factory fabricated plastic plugs shall be used to patch drilled holes in ductwork and housings.



## 2.2 TEST INSTRUMENTS

- A. Utilize test instruments and equipment for TAB work required, of type, precision, and capacity as recommended in the following TAB standards:
  - 1. AABC's Manual "AABC National Standards".
  - 2. Wherever permanently installed measuring equipment is provided, such as air volume monitors, flow meters, temperature and pressure gages, etc., these shall be used in addition to TAB instrumentation. Any discrepancies in accuracy shall be brought to the attention of the Owner. Where permanently installed instrumentation meets accuracy requirements for TAB work, they may be used provided TAB Contractor can verify calibration of installed instruments.
- B. The Contractor shall employ manufactured enclosure type cones, capable of air volume direct readings, for all diffuser air flow measurements.

## PART 3 - EXECUTION

### 3.1 FIELD WORK

- A. Prior to the mechanical installation, the mechanical and TAB contractors shall review the design documents for "balanceability" to confirm that all devices required to properly balance each system are to be provided under this contract. Recommended modifications and/or additions shall be made directly to the engineer and a minimum of 30 days prior to the installation of mechanical equipment.
- B. Examine installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned, operable and accessible. Do not proceed with TAB work until unsatisfactory conditions have been corrected.
- C. Test, adjust and balance environmental systems and components, as indicated, in accordance with procedures outlined in applicable AABC standards. All systems and components shall be balanced within  $\pm 5\%$  of design air and water flows.
- D. Test, adjust and balance system during summer season for cooling and during winter season for heating systems, including operation at outside conditions within 3°F (2°C) wet bulb temperature of maximum summer design condition, and within 10°F (6°C) dry bulb temperature of minimum winter design condition. When seasonal operation does not permit measuring final temperatures, then take final temperature readings when seasonal operation does permit.
- E. Patch holes in insulation, ductwork and housings, which have been cut or drilled for test purposes, in manner recommended by original Installer.

### 3.2 REPORTS

- A. Prepare report of test results, including instrumentation calibration reports, in format recommended by AABC standards. Provide a System Summary page(s) at the front of the report.
- B. An interim/preliminary handwritten report shall be submitted to the Engineer for review prior to the formal submission of the report.
- C. Test reports shall include, but not be limited to, the following information:
  - 1. Air Handling Equipment Test:
    - a. Air handling equipment shall include, but not be limited to, all fans (supply, exhaust, return, relief, make-up, ventilation, etc.), air handling units, fan coil units, etc.).
    - b. Design Conditions: CFM, static pressure, motor h.p., outside air CFM (where applicable), fan and motor RPM and fan motor h.p. for each fan.
    - c. Installed Equipment: Manufacturer, size, arrangement, class, motor h.p., volts, phase, cycles, and full load amps.
    - d. Field Test Results: Fan CFM, fan RPM, fan motor voltage, fan motor operating amps, fan motor operating b.h.p., total static pressure for each fan. In addition, where applicable provide external static pressure, air pressure drop across each coil, filter bank, attenuator, etc. (i.e.. provide total static pressure profile of each system), as well as leaving air temperature, outside air conditions (dry bulb/wet bulb) at time of test, coil flow data (GPM), coil entering and leaving air temperatures, coil entering and leaving water temperatures, coil water pressure drop, VFD settings at final test conditions, and duct static pressure setpoint. Air temperature difference measurements will not be acceptable.
  - 2. Air Distribution Test: Main and major branch ducts and individual supply, return and exhaust terminals (VAV terminals, terminal reheat units,):
    - a. Design Conditions: Ductwork: CFM, duct size. Air terminals, diffusers, registers, grilles: CFM, module size and inlet size.
    - b. Field Test Results: Ductwork: CFM, duct size, number of velocity readings, average velocity reading. Air terminals, diffusers, registers, grilles: CFM, module size and inlet size.
  - 3. Pump Test:
    - a. Design Conditions: GPM, Head, RPM, motor h.p.

- b. Installed Equipment: Manufacturer, size, type drive, motor h.p., volts, phase and cycles, full load amps.
    - c. Field Test Results: Shut-off head, discharge pressure, suction pressure, GPM, operating head, pump motor operating amps, pump motor operating b.h.p., VFD settings at final test conditions and differential pressure setpoint.
  - 4. Heat Exchanger Test:
    - a. Design Conditions: GPM, water pressure drop, entering and leaving fluid temperatures. For chillers provide flow, pressure drop and temperature differential for chilled and condenser water, as well as compressor power input readings.
    - b. Field Test Results: GPM, water pressure drop, entering and leaving fluid temperatures and outside air conditions (dry bulb/wet bulb) at time of test. For chillers provide flow, pressure drop and temperature differential for chilled and condenser water, as well as compressor power input readings.
  - 5. Miscellaneous Test Results:
    - a. All Coils: Air pressure drop, water pressure drop, water flow (GPM), air flow (CFM), entering water temperature, leaving water temperature, entering air temperature, leaving air temperature and outside air temperature at time of test (where applicable) and BTU calculations. Air temperature difference methods will not be acceptable.
    - b. Air Flow Monitors (AFM): Provide verification of AFM accuracy including set-up and adjustment required to verify proper operation and accuracy of each AFM system.
- D. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced; including, where necessary, modifications which exceed requirements of contract documents for mechanical work.
- E. Record outdoor air temperature (dry bulb and wet bulb) at the time of testing air handling units and any other equipment where performance is affected by outdoor air conditions.

### 3.3 TESTS - EQUIPMENT

- A. The contractor shall verify calibration of all indicating, recording, controlling and controlled devices throughout the mechanical system. Verify the proper function of all installed equipment and devices and the interlocking of all new systems as required by the contract documents.

- B. A report including successful calibration and function performance verification of all items indicated above shall be included in the Operations and Maintenance Manual.

### 3.4 FUNCTIONAL PERFORMANCE TESTING AND VERIFICATION

- A. General: In addition to the tests required during and after installation of all mechanical systems, as well as any other formal commissioning requirements, the Contractor shall perform functional performance tests to verify that all systems are designed, installed, calibrated and adjusted to perform as required in the Contract.
- B. Comply with all applicable specification sections including, but not be limited to, "Basic HVAC Requirements", "Testing, Adjusting and Balancing", "Automatic Temperature Controls" and "Commissioning", where applicable.
- C. Prior to functional performance testing, all indicating, recording and control devices shall be calibrated. A verification calibration report shall be provided with the final test report.
- D. Provide functional performance testing to verify proper operation of each and every control sequence indicated throughout the contract documents.
- E. Failure of Tests: Should any test, verification, or demonstration fail to meet the specification requirements, the component of the system causing the failure shall be repaired, replaced or readjusted. The failed test, verification, or demonstration shall then be repeated.
- F. Test Report: Upon satisfactory verification of calibration and functional performance tests, a copy of the final test results shall be bound in the operations and maintenance manual. The final report shall also include a full compliance statement, on company letterhead, indicating that all systems are installed and functioning per the contract requirements including drawings, specifications, control sequences and accepted submittals.
- G. The mechanical systems shall not be considered complete until all functional performance verification forms, calibration reports and compliance statement have been submitted and reviewed. Submit in accordance with the submittal requirements indicated elsewhere in these specifications.

### 3.5 FINAL TESTS, INSPECTION AND ACCEPTANCE

- A. At time of final inspection, Contractor shall recheck, in presence of Owner's Representative, random selections of data (water and air quantities, air motion, and sound levels) recorded in Certified Report. In addition, courtrooms, auditoriums, and conference rooms shall be rechecked. [Laboratories shall be rechecked for satisfactory air flow and motion in vicinity of and through hoods.]
  - 1. Points and areas for recheck shall be selected by Owner's Representative.

2. Measurement and test procedures shall be same as approved for work forming basis of Certified Report.
  3. Selection for recheck (specific plus random), in general, will not exceed 25 percent of total number tabulated in report, except that special air systems may require a complete recheck for safety reasons.
- B. Retests: If random tests elicit a measured flow deviation of 10 percent or more from, or a sound level of 2 db or more, greater than that recorded in Certified Report listings, at 10 percent or more of the rechecked selections, report shall automatically be rejected. In the event the report is rejected, systems shall be readjusted and tested, new data recorded, new Certified Reports submitted, and new inspection tests made, at no additional cost to the Owner.
- C. Marking of Settings: Settings of valves, dampers, and other adjustment devices shall be permanently marked by the Contractor so that adjustment can be restored if disturbed at any time.

END OF SECTION 230593

## SECTION 230800 - COMMISSIONING OF BUILDING AUTOMATION SYSTEMS

### PART 1 – GENERAL

#### 1.1 SUMMARY

- A. Section includes commissioning process requirements for the following building automation system, assemblies, and equipment:
  - 1. BAS and equipment testing and start-up.
  - 2. Validation of proper and thorough installation of BAS and equipment.
  - 3. Functional testing of control systems.
  - 4. Documentation of tests, procedures, and installations.
  - 5. Coordination of BAS training.
  - 6. Documentation of BAS Operation and Maintenance materials.

#### 1.2 GENERAL DESCRIPTION

- A. Contractor Commissioning Responsibilities
  - 1. Prepare Draft Pre-Commissioning Test Report and submit to Commissioning Authority for approval.
  - 2. Execute checkout and record data on the approved pre-commissioning test report forms.
  - 3. Assist commissioning authority in functional performance testing. Assistance shall include but not be limited to the following:
    - a. Attend commissioning progress and coordination meetings.
    - b. Prepare and submit required draft forms and systems information.
    - c. Establish trend log of system operation as specified herein.
    - d. Demonstration of system operation.
    - e. System orientation.
    - f. Manipulate systems and equipment to facilitate testing.
    - g. Provide instrumentation necessary for functional performance testing.
    - h. Manipulate control systems to facilitate functional performance testing.

- i. Monitor the system during the observation period. Prepare and submit all required trend and alarm log data.
- B. Train owner's representatives in systems operation and control equipment use, operation, maintenance and repair. Training shall be conducted as follows:
  1. Control system training shall be conducted by the control subcontractor and as described in this and other sections.
- C. Provide a control technician to work at the direction of commissioning authority for software optimization assistance. Refer to Part 3 of this section for a description of the software optimization.

### 1.3 SUBMITTALS

- A. Submit the following items in accordance with the submittal requirements set forth in Division 01.
  1. Draft Pre-Commissioning Test Report: Submit with BAS submittal, or within 60 calendar days of receipt of approved BAS submittal.
  2. Submit required trend data and alarm logs covering the Observation Period, as specified below.
  3. Submit BAS training plan in accordance with the requirements of other Sections.
  4. Provide detailed control sequences for all peripheral systems. Submittal shall include two electronic, and four hard copies of programmed logic, in each individual systems respective native programming language.
  5. Hardware and software submittals.
  6. Control panel construction shop drawings.
  7. Narrative description of each control sequence for each piece of equipment controlled.
  8. Diagrams showing all control points, sensor locations, point names, actuators, controllers and, where necessary, points of access, superimposed on diagrams of the physical equipment.
  9. Logic diagrams showing the logic flow of the system.
  10. A list of all control points, including analog inputs, analog outputs, digital inputs, and digital outputs. Include the values of all parameters for each system point. Provide a separate list for each standalone control unit.
  11. A complete control language program listing including all software routines employed in operating the control system. Also provide a program

write-up, organized in the same manner as the control software. This narrative shall describe the logic flow of the software and the functions of each routine and sub-routine. It should also explain individual math or logic operations that are not clear from reading the software listing.

12. Hardware operation and maintenance manuals.

13. Application software and project applications code manuals.

- B. Participate fully in commissioning as specified in Section 019110 "General Commissioning Requirements." See Section 019110 for a specific list of equipment and systems to be covered by the commissioning process.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

### 3.1 INSTRUMENTATION

- A. Instrumentation required to verify readings and test system and equipment performance shall be provided by Contractor and made available to Commissioning Authority. Generally, no testing equipment will be required beyond that required to perform Contractor's work under these Contract Documents. Equipment used for testing and calibration shall be NIST/NBS traceable and calibrated within the preceding 6-month period. Certificates of calibration shall be submitted upon request.

### 3.2 TESTING ADJUSTING BALANCING AND COMMISSIONING PORTABLE OPERATORS TERMINAL

- A. Provide a portable operators terminal or hand held device to facilitate TAB and calibration. This device shall support all functions and allow querying and editing of all parameters required for proper calibration and start up.
- B. Connections shall be provided local to the device being calibrated. For instance, for VAV boxes, connections of the operator's terminal shall be either at the room sensor or at the box.

### 3.3 COMMISSIONING AUTHORITY WORKSTATION AND PROGRAMMING SOFTWARE

- A. Provide Commissioning authority with copies of software, licensing, and master passwords required to add, change, view, and port, control logic within Universal Network Controller, individual Field Controllers, and all other systems, or subsystems requiring stand-alone logical instruction sets, within the described BAS system, including variable frequency drives, for two remote workstations. Software shall include all workstation software required to view, edit and create system graphics, database, programming, trends, and the like. Software shall



include unfettered ability to add or modify field devices, modules, and subsystems, which may communicate using any existing BAS protocol. This shall include any software requirements specific time and with free updates and automatic notifications for upgrades.

3.4 BAS PRE-COMMISSIONING, START-UP TESTING, ADJUSTING, AND CALIBRATION

- A. Work and/or systems installed under this Division shall be fully functioning before Demonstration, Observation Periods and Contract Close out. Contractor shall start, test, adjust, and field calibrate all work and/or systems under this Contract, as described below:
1. Inspect the installation of all devices. Review the manufacturer's installation instructions and validate that the device is installed in accordance with the instructions. Ensure that all devices are "readily accessible" for service and maintenance.
  2. Verify proper electrical voltages and amperages, and verify that all circuits are free from faults.
  3. Verify integrity/safety of all electrical connections.
  4. Verify proper interface with alarm and security systems as applicable.
  5. For the following control settings, initially use the control setting that was used by existing control system, unless otherwise indicated. For AHUs that use a throttled outside air damper position when minimum outside air is required, contractor shall mark existing minimum outside air damper position to allow replication by new controls.
  6. Coordinate with TAB subcontractor and CxA to obtain fine tuning control settings that are determined from balancing procedures. Record the following control settings as obtained from TAB contractor, and not any TAB deficiencies in the BAS Pre-commissioning Report:
    - a. Minimum flow setpoints for chillers
    - b. Maximum flow setpoints for chillers
    - c. Optimum differential pressure setpoints for variable speed pumping systems.
  7. Test, calibrate, and set all digital and analog sensing, and actuating devices. Document calibration of each instrumentation device, at a normal operating point, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to calibrated (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range). Record the measured value and displayed value for each device in the BAS Pre-Commissioning Report.

8. Check and set zero and span adjustments for all transducers and transmitters.
9. For valves:
  - a. Check for adequate installation including free travel throughout range and adequate seal.
  - b. Where loops are sequenced, check for proper control without overlap.
10. For actuators:
  - a. Check actuated devices under operating conditions. Manually activate damper and valve operators to verify free travel and fail condition. Check valve or damper to insure that it shuts off tightly when the appropriate signal is applied to the operator.
  - b. Check for appropriate fail position, and that the stroke and range is as required.
11. Check each digital output control point by making a comparison between the control command at the control unit or operator workstation and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the control unit or operator workstation display. Record the results for each device in the BAS Pre-Commissioning Report.
12. For outputs to reset other manufacturer's devices (for example: variable frequency drives) and feedback from them, calibrates ranges to establish proper parameters. Coordinate with representative of the respective manufacturer and obtain their approval of the installation.
13. Verify proper sequences by using the approved checklists to record results and submit with BAS Pre-Commissioning Report. Verify proper sequence and operation of all specified functions.
14. Verify all safety devices trip at appropriate conditions. Adjust setpoints accordingly.
15. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the BAS Pre-Commissioning Report. Except from a startup or set change in setpoint, maximum allowable variance from set point for controlled variables shall be as follows. Within 3 minutes of any upset (for which the system had the capability to respond to) in the control loop, tolerances shall be maintained (exceptions noted):
  - a. Water pressure: +/- 1 psig.

16. For interface and DDC control panels:
  - a. Ensure devices are properly installed with adequate clearance for maintenance and clearly labeled in accordance with the record drawings.
  - b. Ensure terminations are safe, secure and labeled in accordance with the record drawings.
  - c. Check power supplies for proper voltage ranges and loading.
  - d. Check for adequate signal strength on communication networks.
  - e. Check for standalone performance of controllers by disconnecting the controller from the LAN. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.
  - f. Ensure all outputs and devices fail to their proper position/states.
  - g. Ensure all outputs and devices follow the correct manual, and autonomous re-initialization sequence upon alarm reset.
  - h. Ensure buffered and/or volatile information is held through power outage.
  - i. With all system and communications operating normally, sample and record update/enunciation times for critical alarms fed from the panel to the OWS.
  - j. Check for adequate grounding of all DDC panels and devices.
17. For Operator Interfaces:
  - a. Verify all elements on the graphics are functional and properly bound to physical devices and/or virtual points and that hot links or page jumps are functional and logical. Graphics should comply with the visual standards established by the Owner. Samples to be provided to contractor by owner upon request to ensure accuracy during development.
  - b. Output all specified BAS reports for review and approval.
  - c. Verify the alarm printing and logging is functional and per requirements.
  - d. Verify trend archiving to disk and provide a sample to the CxA for review.
  - e. Verify paging/dial out alarm enunciation is functional.

- f. Verify alarms are sent via email, and SMS (text messaging), with priorities to be determined by end user definable notification criteria; to building and O&M representatives.
  - g. Verify functionality of remote operator interfaces and that a reliable connection can be established consistently.
  - h. Verify that required third party software applications required with the bid are installed and functional.
- B. Submit Start-Up Test- Report. Report shall be completed, submitted and approved before Substantial Completion.

### 3.5 SENSOR CHECKOUT AND CALIBRATION

- A. General Checkout: Verify that all sensor locations are appropriate and away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor groups that are used to determine a temperature or pressure difference, make sure they are reading within 0.2 F of each other for temperature and within a tolerance equal to 2% of the reading, of each other for pressure. Tolerances for critical applications may be tighter.
- B. Calibration: Calibrate all sensors using one of the following procedures.
  - 1. Sensors without transmitters and sensors with integral transmitter – Standard Application:
    - a. Make a reading with a calibrated test instrument within 6 inches of the site sensor at various points across the range. Verify that the sensor reading (via the permanent indicator or BAS) is within the tolerances specified for the sensor. If not, adjust offset and range as necessary, or replace sensor. For sensors operating within a narrow range (for example: space temperature, space humidity, chilled water, and similar applications) a single point reading shall be acceptable.
  - 2. Sensors with transmitters that require separate calibration – Standard Application:
    - a. Disconnect sensor, connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacture's resistance-temperature data simulate minimum desired temperature. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the OI. Record all values and recalibrate controller as necessary to conform to tolerances. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent indicator or BAS) is within the tolerances specified. If

not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.

- C. Sensor Tolerance: Sensors shall be with the tolerances specified for the device.

### 3.6 LOOP TUNING

- A. For all control loops, contractor shall tune the loops to ensure the fastest stable response without hunting, offset or overshoot. Contractor shall introduce upsets to the load when possible to affect response. Otherwise, setpoints can be changed to affect the response.
- B. All final PID loop parameters shall be recorded in the shop drawings, and BOP.
- C. Generally tune loops during periods of high gain.
- D. Document all parameters either by capturing text, short interval trends, or screen shots of trend graph documenting the final response.

### 3.7 VALVE STROKE SETUP AND CHECK

- A. For all valve and actuator positions checked, verify the actual position against the Output-Input readout.
- B. Set pumps to normal operating mode. Command valve closed, verify that valve is closed and adjust output signal as requires. Command valve to a few intermediate positions. If actual valve position does not reasonably correspond, replace actuator or add pilot positioned (for pneumatics).

### 3.8 BAS DEMONSTRATION AND ORIENTATION

- A. The intent of the demonstration and orientation is to provide owner and commissioning authority with a reasonable level of assurance that the system is complete and ready for functional performance testing, and to provide an initial orientation to the system configuration, set-up, features, and commissioning related procedures.
- B. Demonstrate the operation of a sampling of the BAS hardware, software, and all related components and systems to the satisfaction of the commissioning authority. Schedule the demonstration with owner's representative 2 weeks in advance. Demonstration shall not be scheduled until all hardware and software submittals, and the pre-commissioning documentation has been submitted to and reviewed by the commissioning authority. Should the work fail to be demonstrated to be completed and ready for functional testing, so as to require additional site visits by the commissioning authority for re-demonstration, contractor shall reimburse owner for all costs of subsequent commissioning authority site visits for demonstration.
- C. The contractor shall supply all personnel and equipment for the demonstration, including, but not limited to, instruments, ladder, etc. Contractor supplied

personnel shall be competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems. All documentation and submittals shall be at the job site.

- D. The system shall be demonstrated following the same procedures used in the pre-commissioning test. Demonstration shall include, but not necessarily be limited to, the following.
1. Demonstrate that all required software is installed on BAS workstations. Demonstrate that all graphic screens, alarms, trends, and reports are installed as submitted and approved.
  2. Demonstrate that a sampling of points specified and shown can be interrogated and/or commanded (as applicable) from all workstations, as specified.
  3. Demonstrate that remote dial-up communication abilities (as applicable) are in accordance with contract requirements.
  4. Demonstrate correct calibration and calibration procedures for a sampling of input/output devices selected by owner and commissioning authority.
  5. Demonstrate that all DDC and other software programs exist at respective field panels. The Direct Digital Control (DDC) programming and point database shall be submitted and approved.
  6. Demonstrate that all DDC programs accomplish the specified sequences of operation.
  7. Demonstrate that the panels automatically recover from power failures, as specified.
  8. Demonstrate that the stand-alone operation of panels meets the requirements of these Specifications. Demonstrate that the panels' response to LAN communication failures meets the requirements of these Specifications.
- E. BAS Demonstration shall be completed before Substantial Completion.

### 3.9 TREND LOGS

- A. Trend logs are databases of ASCII characters (usually numbers) representing a historical record of the systems operation. Contractor shall establish and store these trend logs. Trend logs shall be prepared for each physical input and output point, and all dynamic virtual points such as set points subject to a reset schedule, intermediate set point values for cascaded control loops, and the like. Trend logs shall be maintained, and shall encompass no less than three years of historical data.
- B. CxA will analyze trend logs of the system operating parameters to evaluate normal system functionality. Contractor shall establish these trends, ensure they are being

stored properly, and forward the data in electronic format to the CxA upon completion of the observation period.

- C. Data shall include a single row of field headings and the data thereafter shall be contiguous. Each record shall include a data and time field. Recorded parameters for a given piece of equipment or component shall be trended at the same intervals and be presented in a maximum of two separate two dimensional formats with time being the vertical axis and field name being the horizontal axis. Data shall be forwarded in one of the following formats.
  - 1. Microsoft EXCEL Spreadsheet (.xls)
  - 2. Open Source (.ods)
  - 3. Comma Separated Value (.csv or .txt) preferably with quotes delimiting text fields and # delimiting date/time fields.
- D. Sample times indicated as COV (+/-) or change of value mean that the changed parameter only needs to be recorded after the value changes by the amount listed. When output to the trending file, the latest recorded value shall be listed with any given time increment record. If the BAS does not have the capability to record based on COV, the parameter shall be recorded based on the interval common to the unit.
- E. A complete set of trend logs shall consist of all required points, trended for the time period listed for each point category. Point values shall be recorded based on the Change of Value (COV) differentials listed. If the BAS does not have the capability to trend based on COV, then point values shall be trended based on the time intervals listed:
- F. Contractor shall provide the CxA with required passwords, phone numbers, etc. to allow the CxA access to the trend log data and allow downloading to a remote location. Contractor shall also provide step by step written instructions for accessing the data.

### 3.10 TREND GRAPHS

- A. Trend graphs shall generally be used during the functional testing and Observation Periods to facilitate and document testing. Prepare controller and workstation software to display graphical format trends during the observation Period. Trend graphs shall demonstrate compliance with contract documents. Trended value and intervals shall be the same as those specified for the functional performance test.
- B. Lines shall be labeled and shall be distinguished from each other by using either different line types, or different line colors.
- C. Indicate engineering units of the y-axis values; e.g. degrees F., inches w.g., Btu/lb, percent wide open, etc.

- D. The y-axis scale shall be chosen so that all trended values are in a readable range. Do not mix trended values on one graph if their unit ranges are incompatible.
- E. Trend outside air temperature, humidity, and enthalpy during each period in which any other points are trended.
- F. All points trended for one HVAC subsystem (e.g. air handling unit, chilled water system, etc.) shall be trended during the same trend period.
- G. Each graph shall be clearly labeled with HVAC subsystem title, date, and times.

### 3.11 POST FUNCTIONAL PERFORMANCE PROCEDURES

- A. Participate in the following commissioning activities for systems covered by this section following completion of functional performance procedures.
  - 1. Integrated Systems Procedures.
  - 2. Emergency System Procedures.

### 3.12 WARRANTY PHASE BAS OPPOSITE SEASON TRENDING AND TESTING

- A. Trending: Throughout the Warranty Phase, trend logs shall be maintained as required for the Observation Period. Contractor shall forward archive trend logs to the CxA for review upon CxA's request. CxA will review these and notify contractor of any warranty work required.
- B. Opposite Season Testing: Within 10 months of completion of the Observation Phase, CxA shall schedule and conduct Opposite Season functional performance testing. Contractor shall participate in this testing and remedy any deficiencies identified.

### 3.13 SOFTWARE OPTIMIZATION ASSISTANCE

- A. The contractor shall provide the services of a controls technician for a maximum of 16 man-hours at the project site to be at the disposal of the Commissioning Authority. The purpose of this requirement is to make changes, enhancements and additions to control unit and/or workstation software that have been identified by the commissioning authority during the construction and commissioning of the project and that are beyond the specified contract requirements. Any work to correct deficiencies covered under warranty shall not be applicable toward these 16 man-hours. The cost for these services shall be included with the bid. Requests for assistance shall be for contiguous or non-contiguous 8 hour days, unless otherwise mutually agreed upon by contractor, commissioning authority, and owner. Owner's representative shall notify contractor 2 days in advance of each day of requested assistance.
- B. The controls technician provided shall be thoroughly trained in the programming and operation of the controller and workstation software. If the controls technician provided cannot perform every software task requested by the commissioning



Authority in a timely fashion, contractor shall provide additional qualified personnel at the project site as requested by the Commissioning Authority, to meet the specified time requirement.

- C. If any part of this requirement is scheduled during the Observation Period, such changed made because of this requirement shall not prevent approval of the Observation Period. However, during the Opposite Season Observation Period such changes shall be demonstrated to perform as documented by the Commissioning Authority.

#### 3.14 BAS OPPOSITE SEASON OBSERVATION PERIOD

- A. During the warranty period, but no later than 6 months from completion of the initial Observation Period BAS shall enter an Opposite Season Observation Period of two weeks. Opposite Season Observation Period shall not be scheduled until seasonal conditions have changed to the opposite of those that occurred during the initial observation period. Schedule the beginning of the opposite season observation period with owner's representative 2 weeks in advance. All requirements specified for the observation period shall also apply to the opposite season Observation Period.

#### 3.15 ADDITIONAL COMMISSIONING

- A. Perform additional commissioning activities required after system adjustments, replacements, etc., are completed.

#### 3.16 DEMONSTRATION

- A. Commissioning performance verification does not substitute for demonstration of equipment and system performance to Owner's personnel.

#### 3.17 TRAINING

- A. Provide services of controls contractor's qualified technical personnel for three (3), four (4) hour sessions to instruct owner's personnel in operation and maintenance of control systems. Instruction shall be in a classroom setting at the project site. Requests for assistance shall be for contiguous or non-contiguous 4-hour sessions at the Owner's discretion. Owner's representative shall notify contractor 1 week in advance of each day of requested training.
- B. The Contractor shall include training time devoted specifically to logic programming, and flow structure of "back-end" peripheral field control systems, modules, VFD's, subsystems, and communication protocols. Contractor shall provide detailed control sequences for all peripheral systems. This shall include two electronic, and four hard copies of programmed logic, in each individual systems respective native programming language.
- C. Provide up to 4 complete sets of the approved operations and maintenance manual to be used for training.

- D. Submit a training plan for installed system hardware and software. Include training time devoted specifically to logic programming, and flow structure of “back-end” peripheral field control systems, modules, VFD’s, subsystems, and communication protocols. Supply programming software documentation and instruction sets.
- E. The contractor’s designated training personnel shall meet with the commissioning authority and owner’s representative for the purpose of discussing and fine tuning the training agenda before the first training session.
- F. Short Video Clips – These should be about 1 minute more or less in to provide sufficient explanation to allow an individual to perform the action. The short clips should be provided on a CD with labeled links to each video. They should also be placed on the server in order to access as part accessing the BAS.
  - 1. How to change a set point
  - 2. How to change a schedule
  - 3. How to add a schedule to a piece of equipment
  - 4. How to create a schedule
  - 5. How to set up a single trend
  - 6. How to set up multiple trends
  - 7. How to back up the data / system
  - 8. How to get BAS system to recognize a new piece of compatible equipment using BACnet / Modbus, LonWorks and non proprietary functions for such components as a VFD or AHU Controller or an individual sensor (IP addressable)
  - 9. How to add text window into a graphic screen
  - 10. How to add a data point into a graphic screen window (such as outdoor air temperature)
  - 11. How to create a hyperlink to a CD that has the O & M data pdf
  - 12. How to adjust or calibrate a device (temperature sensors, pressure transmitters, etc.)
  - 13. How to add a sensor type wireless device
- G. There is a lot more to the DDC system but the level of knowledge/training is beyond what this particular effort is trying to capture. The short clips should be

done in a manner where nearly anyone with basic knowledge of BAS system would be able to perform the task.

END OF SECTION 230800

## SECTION 230900 - AUTOMATIC CONTROL SYSTEMS (ELECTRIC-ELECTRONIC)

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Scope: The extent of automatic controls work is indicated on the drawings and schedules and by the requirements of this Section, and all other Division-23 sections. The work includes, but is not limited to the following:
1. The provision of a complete and operational control system, including all devices necessary to perform the functions herein described or indicated on the drawings.
  2. The provision of 120 and 208 volt line voltage and 5 and 24 volt low voltage wiring and conduit types shall be installed in accordance with Division-26 of these specifications.
  3. The ATC contractor shall furnish and install all electrical wiring and conduit from power source, including termination, to all required ATC related power connections including, but not limited to, DDC controllers (provide low voltage controllers for air terminal units including transformers and disconnect switches as required), sensors, valve and damper actuators (including smoke dampers), air flow monitors, ATC panels, etc. The ATC contractor shall be wholly responsible for all power requirements necessary for a complete installation from the power source to all ATC related connections. The intended power source shall be as indicated on the electrical plans. All electrical work shall be installed in accordance with Division-26 of these specifications.
    - a. Existing conduit may be reused if in good condition and will not cause conflict with phasing of work.
  4. The ATC contractor shall interface with fire alarm devices as required to accomplish equipment shutdown, alarms, etc. indicated in sequences.
  5. The ATC contractor shall coordinate and verify that all controllers, devices, and accessories are provided as required to accomplish all control functions and sequences indicated in the contract documents. Where control related devices are not provided by an equipment manufacturer, it shall be the responsibility of the ATC contractor to provide the control devices required to accomplish the functions and sequences indicated.
  6. All drilling, cutting and patching associated with the installation of control systems.
- B. Types: Provide automatic control systems of the following types:

1. Direct Digital Control (DDC) with electric actuation of valve and damper actuators.
  2. The automatic temperature control system shall include remote interface and web access capability. All building management system control features including, but not limited to, points, alarms, scheduling, graphics, trending, etc. shall be available for control and monitoring through web access as well as remote interface (coordinate exact location with the using agency, where applicable).
- C. Custom Reports: Provide all custom reports within the Building Management System required for the owner's operation of the facility, including but not limited to: schedules, metering reports, lighting scenes, etc... Scope shall include fifty (50) custom reports.
1. The custom reports shall be coordinated with what is in the existing BAS system and with the Owner's facility staff.
- D. Establish existing conditions for a baseline. All currently monitored and controlled points in the existing BAS shall be verified and the same functionality shall be included in the new BAS.
1. Document all currently monitored and controlled points in the existing BAS. Document all current custom reports and templates.
  2. Contractor shall use the available BAS record documents, the current BAS workstation, and Owner's facility personnel to establish the baseline existing system.
- E. Related Sections: Possible related sections include, but shall not be limited to, the following:
1. Section 25 00 10 Intelligent Building Management System (iBMS)

## 1.2 QUALITY ASSURANCE

- A. Systems Engineering: The systems engineering phase shall include the selection and integration of components into a complete system which will meet the performance and prescriptive requirements of the Contract, together with drawings, specifications, descriptions of operation, diagrams and other materials listed under "Submittals" paragraph of this Section.
- B. Testing and Adjusting During and After Installation:
1. The testing and adjusting includes the submission of a test plan which shall describe in detail the method by which each component, subsystem, and system will be tested, calibrated, adjusted, and retested after installation in accordance with the specified sequences of operation and other characteristics of the control system. A report on test results, including set points and operating ranges of all components shall be submitted.

2. The testing specified in this paragraph shall not replace the testing specified in "Commissioning Tests and Verification" article of this Section.
- C. Commissioning Testing and Verifications: The final phase of the quality assurance program of the project is the commissioning testing and verifications. This phase is to assure that the project is fully completed and that the systems are performing in accordance to specifications from end to end of the control systems. Demonstrations of the automatic control systems to the commissioning team in accordance to the requirements specified in Part 3 of this Section are required. A report on test results, including set points and operating ranges of all components, shall be submitted.
- D. Testing: The testing phase of quality assurance includes the submission of a test plan which shall describe in detail the method by which each component, subsystem, and system will be tested, calibrated and retested after installation to perform in accordance with the specified sequences of operation and other characteristics of the control system.
- E. Reporting and Demonstration: This phase shall include the submission of a written report describing the "actions taken during the testing" phase, and including the set points and operating ranges of all equipment and a demonstration that the system performs in accordance with contract requirements.
- F. Operating Instructions and Training: This phase of quality assurance includes the training of operating personnel utilizing written operating instructions prepared and approved under the "Submittals" paragraph of this Section, and the mounting of laminated control diagrams where directed.
- G. Maintenance Manuals: This phase includes the submission of all manufacturers' cuts, maintenance and operating instructions, test reports and demonstration material, copies of control diagrams, and copies of the manufacturers' certifications. Two (2) CDs, DVDs, flash drives or other current electronic media device including the maintenance manuals shall be provided to the Owner (cloud storage is not an acceptable substitute). One (1) hard bound copy of the maintenance manual shall be provided to the Owner.

### 1.3 SUBMITTALS

- A. Shop Drawings: For each system to be controlled, prepare a drawing which includes a system flow diagram, control diagram, sequence of operation and schedule of components. Control diagrams shall be complete with end-to-end connections of piping and wiring from component terminal.
- B. Manufacturer's Data: For each manufactured device or subsystem submit manufacturers' specifications and printed photograph of the proposed device or subsystem. Include engineering descriptions, principle of operation and application, and proposed model, style or size clearly indicated.

- C. Custom Reports required under the Summary Section shall be submitted for review and approval.
  - 1. List of Custom Reports to be included.
  - 2. Custom Report Templates
  - 3. Complete Custom Reports
- D. Existing Sequences, Points, and Reports: Contractor shall submit for record.
  - 1. Document all currently monitored and controlled points in the existing BAS.
  - 2. Document all current custom reports and templates.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis of Design Product: Subject to compliance with requirements, provide products by one of the following pre-qualified manufacturers:
  - 1. Schneider Electric EcoStruxure Building MP/RP BACnet series, b3 BACnet series, MNB BACnet, MNL LON, Xenta LON series installed by approved manufacturer's local field office or authorized distributor.
  - 2. Niagara Framework technology as developed by the Tridium Corporation. All tools and hardware provided shall comply with the current release of the Niagara 4 Framework platform.

### 2.2 INSTALLER AND SERVICE PROVIDER

- A. The automatic temperature controls shall be furnished, installed, commissioned and warranted by one of the following acceptable providers:
  - 1. A licensed provider for one of the BAS product manufacturers listed in section 2.1.
  - 2. An approved manufacturer's local office or authorized distributor for one of the BAS product manufacturers listed in section 2.1..
- B. Manufacturers not listed above will not be acceptable.

### 2.3 SYSTEMS INTEGRATION

- A. Control Loop Characteristics: Carefully evaluate the characteristics of each control loop, the time constants, equipment characteristics, control accuracy, and reliability and provide a system which will operate smoothly, without hunting, and within the accuracies specified.

- B. System Components: Select components including sensors, transmitters, controllers, control devices, actuators, and instrumentation considering such factors as hysteresis, relaxation time, span, limits, and response time.

## 2.4 CONTROLLERS

- A. General: Provide electric or electronic controllers for each local control loop.
  - 1. Provide controllers with local adjustable setpoint, adjustable proportional band for analog controllers or adjustable differential for two position controllers.
  - 2. Provide adjustable secondary input authority for dual input controllers with remote setpoint adjustment.
  - 3. Provide integral or test connections for measuring input and output signal.
- B. Electric/Electronic System Characteristics: Provide a system of control which shall have all of the following system characteristics. Systems which do not conform to all of the following requirements will not be acceptable.
  - 1. The system shall consist of multiple, field adjustable controllers. The controller, power supplies, input/output and other components specified, including metal cabinet will be referred to as a "Field Panel."
  - 2. The field panel shall be capable of performing its assigned local loop control and other functions as a standalone unit. It shall perform all specified local loop control functions without interaction to other field panels, except for shared functions such as central time programs, heating-cooling changeover, etc.
  - 3. The field panel shall utilize control algorithms that permit proportional, integral, and derivative control as required. Control algorithms shall permit one, two or three mode control as specified or indicated on the drawings.
  - 4. Each field panel shall be capable of handling multiple control loops, with one or more controllers.
  - 5. The system shall utilize industry standard sensors.
  - 6. The field panel shall provide both analog and binary output control. Analog outputs shall be compatible with industry standard transducers. Provide a modulating analog output control signal. Binary output control commands shall be implemented through interposing control relays.
  - 7. Field panels shall be of modular construction. The system shall utilize interchangeable components. The modular construction of the system shall permit quick repair, ease of expansion, and the use of standard controls.



8. Each field panel with sensors and controlled devices shall be capable of automatic, unattended restart in the event of electrical power failure. In the event of electrical power failure all controlled devices shall move to their predetermined "normal" positions. By normal, it is meant that spring-close valves shall close, spring-open devices shall open, spring return devices will return and magnetically held devices will move to the position dictated by the force of gravity. Upon the restoration of electrical power, the field panel shall automatically restart and provide control to its connected systems after power failures of up to 72 hours.
9. The field panel operating system shall reside in nonvolatile memory.
10. Site specific application data, setpoints and operator entered data shall be stored in volatile memory.
11. Nonvolatile memory shall include PROM, EPROM, EAROM, ROM and RAM.
12. The preceding terms describe a class of solid state semi-conductor memories manufactured with LSI (large-scale-integration) techniques. These terms are expanded as follows:
  - a. PROM - Programmable Read Only Memory
  - b. EPROM - Erasable PROM
  - c. EAROM - Electrically Alterable ROM
  - d. ROM - Read Only Memory
  - e. RAM - Random Access Memory

C. Field Panels: Provide field panels as follows.

1. Each field panel shall consist of a controller, power supplies, input/output modules, and other components specified.
2. Provide field panels where indicated. Provide additional controllers, if required, to support the control loops specified, the sequence of operations, number of monitoring points or other criteria to permit the field panel capacity to meet the specified functional requirements of the project.
3. Each field panel shall be capable of operation as a completely independent unit.
4. Each field panel or controller shall include its own operator's keypad or other means of adjustment on site by the operator.

5. Each field panel shall receive signals from industry standard sensors and input devices. Each panel shall have the capability to monitor the following types of inputs:
  - a. Analog inputs: 4 to 20 mA and 0 to 10 V DC.
  - b. Binary inputs: Dry contact closure and pulse accumulator.
  - c. Provide transducers and/or signal conditioning to adapt other sensor types.
  - d. Field panels that permit the direct connection of resistance type sensors will be acceptable if the system accuracy, data resolution, value accuracy and sensor interchangeability, comply with all other requirements of the specification.
6. The field panel shall directly control actuators and control devices. Each field panel shall be able to provide the following control outputs:
  - a. Binary outputs: Contact closure
  - b. Analog outputs: 4 to 20 mA, 0 to 10 V DC and 0 to 135 OHM.
  - c. Systems that do not provide direct analog outputs will be acceptable providing that they generate the specified output signal through transducers.
7. Each field panel shall perform control functions and other routines, specified under Sequences of Operation.
8. Each field panel shall accept binary inputs, on-off, open-close, or other two state data. Provide isolation and protection against input voltage up to 180 VAC peak.
9. Each field panel shall provide Binary Output by contact closures for momentary and maintained operation of field devices. Provide electromagnetic interference suppression on all output lines to limit transients to non-damaging levels. Provide isolation and protection against voltage up to 180 VAC peak. Provide contacts rated for 2 A at 24 VAC.
10. Each field panel shall be enclosed in a metal cabinet. The cabinet shall be constructed of 16 US gauge sheet steel, Provide sufficient access for wire and conduit to enter the cabinet. The cabinet shall have a hinge door and a pin tumbler lock. All field panel locks for the project shall be keyed alike. The cabinet shall be shipped to the project for installation without electronics. The electronics shall be added at the time of wire termination and system commissioning. All control wiring and system communications shall be electrically terminated inside the field panel.

11. Provide a 15A duplex receptacle inside or immediately adjacent to the field panel. The receptacle shall be energized when power is disconnected from the field panel.
  12. Ground the field panel and power supply with a minimum No. 12 THHN unbroken ground wire to the building earth ground system. There shall be a maximum of 5 ohms measured between the ground at the field panel and the building ground system.
  13. Provide a master electrical power disconnect switch inside the field panel to disconnect all external power to the cabinet for maintenance and repair. The disconnect switch shall not affect the duplex receptacle hereinbefore specified.
  14. Provide screw type terminal strips in the field panel for the termination of all field wiring. Lay out terminal strips in a neat and orderly fashion and label each termination. All wiring entering the panel shall be routed through the panel wireways in a neat and workmanlike manner, properly tied or laced and terminated.
  15. Provide conduit and wire to connect the field panel to the nearest adequate source of emergency electric power.
- D. Wire/Cable Labeling: Label wire and cable as follows.
1. Label each cable and each conductor within 6 inches (150 mm) of the termination point. Cable and wire identification shall match the wiring identification shown on the installation and record drawings.
  2. Wire identification labels shall be securely affixed to the wire and shall be of the preprinted type providing a durable vinyl or plastic covering over the printed lettering.
  3. Wire identification through color coding, embossed label tape, paper tags attached with string and handwritten labeling will not be acceptable.
- E. Transient Protection: Provide transient protection as required by the manufacturer.
- F. System Accuracy: Provide system accuracy in accordance with the following.
1. Each local system shall maintain end-to-end accuracy for one year from sensor to controlled device for the applications specified.
  2. Space temperature with a range of 50°F to 85°F (10°C to 29°C) plus or minus 0.75°F (.4°C) for conditioned space; 30°F to 130°F (-1°C to 54°C) plus or minus 1.0°F (.6°C) for unconditioned space.
  3. Duct temperature with a range of 40°F to 140°F (4°C to 60°C) plus or minus 1.0°F (.6°C).

4. Outside air (OA) temperature with a range of minus 30°F to plus 130°F (minus -1°C to plus 54°C) plus or minus 2.0°F; with a subrange of plus 30°F to plus 100°F (plus -1°C to plus 38°C) plus or minus 1.0°F (.6°C).
  5. Water temperature with a range of 33°F to 100°F (1°C to 38°C) plus or minus 0.75°F (.4°C); the range of 100°F to 250°F (38°C to 121°C) plus or minus 2.0°F (1.2°C); and water temperatures for the purpose of performing BTU calculations using differential temperatures to plus or minus 0.5°F (.3°C) using matched sensors.
  6. High temperature water with a range of 0°F to 500°F (-18°C to 260°C) plus or minus 3.0°F (1.6°C).
  7. Pressure with a range for the specific application plus or minus 2.0 percent of range.
  8. Flow with a range for the specific application plus or minus 3.0 percent of range, and flows for the purpose of BTU calculations to plus or minus 2.0 percent of range.
- G. Accuracy and Stability: Equipment shall be selected for the appropriate range of the application. Equipment selected with ranges in excess of the application will be replaced at the Contractor's expense.

## 2.5 SENSORS

- A. General: Provide analog sensors for temperature controllers. Provide sensors with an output signal that varies continuously with the sensed temperature, within a specified range, of the thermistor or resistance type.
- B. Manufacturer: Temperature sensors shall be made by one manufacturer.
- C. Space Sensors: Provide space or room sensors with base plates thru-bolted into masonry or wall studs, brushed cast aluminum or 16 gauge (1.6 mm) ground and polished Type 316 stainless steel covers.
- D. Insertion Type: Stem or extended surface sensitive type with screw mounting plate and galvanized sheet steel insulation mounting box.
- E. Immersion Type: Stem or tip sensitive type with threaded immersion well base.
- F. Sensing Elements: Hermetically seal, except for bimetal type for room thermostats. Stem, tip or extended element shall be Type 304 stainless steel or annealed copper.
- G. Casing: Casing shall be constructed of watertight, vibration-proof, heat resistant high strength phenolic or 316 stainless steel.
- H. Sensor Wells: Provide 304 stainless steel, bronze, copper or monel machined wells, compatible with the immersion medium, and heat sensitive transfer material or liquid between sensor and well surface.

## 2.6 ELECTRONIC ANALOG SENSORS

- A. Range: Sensors shall operate within the range of minus 30°F to plus 220°F (minus -34°C to plus 104°C) for heating, ventilating and air conditioning (HVAC) systems.
- B. High Temperature Sensors: For high temperature water applications provide sensors with a range of 0°F to 500°F (-18°C to 260°C).
- C. Accuracy: Provide electronic analog sensors with an accuracy of plus or minus 0.25°F (.14°C).
- D. Time Constant Response: Provide sensors with a time constant response to achieve 60 percent of a step temperature change in six (6) seconds in air or water flowing at 3 feet per second (.9 m/s).
- E. Interchangeability: Sensors of the same type shall be interchangeable without calibration.

## 2.7 PRESSURE SENSORS

- A. Overpressure Protection: Provide pressure sensors impervious to instantaneous pressure changes of 150 percent of working pressure but not less than plus or minus 50 psig (340 kPa).
- B. Adjustment: Provide sensors with external adjustable span, adjustable zero and pulsation suppression.
- C. Finished Spaces: Conceal pressure sensors in recessed stainless steel housing with removable perforated brushed stainless steel cover.
- D. Sensor Characteristics: Provide pressure sensors with the following characteristics:
  - 1. Ambient Temperature: 40°F to 140°F (4°C to 60°C).
  - 2. Isolation Valves: Provide pressure sensors with stainless steel needle isolation valves between each sensor and sensor pressure source. Provide differential pressure sensors with 3-valve manifold for isolation and nulling.
  - 3. Siphon: On steam systems provide pressure sensors with a pigtail siphon between the sensor isolation valve and sensor. Provide condensate wells and blowdown valves for differential pressure sensors.
  - 4. Provide switching type sensors with platinum alloy, silver alloy or gold plated wiping contacts rated for the application, voltage and power levels.
  - 5. Provide valved calibration taps adjacent to each pressure sensor for calibration.

## 2.8 STATIC PRESSURE ANALOG SENSORS

- A. Types: Provide diaphragm sensors with solid state pre-amplifier electronic systems.
- B. Characteristics: Provide analog sensors with the following characteristics:
  - 1. Sensor span shall be not less than 150 percent and not more than 300 percent of the working pressure.
  - 2. Accuracy shall be 0.5 percent of calibrated span including combined effects of linearity, hysteresis and repeatability.

## 2.9 DIFFERENTIAL PRESSURE ANALOG SENSORS

- A. Types: Provide differential pressure analog sensors of the solid state pre-amplifier types for electronic systems.
- B. Characteristics: Provide sensors with the following characteristics:
  - 1. Sensor span not less than 150 percent nor more than 300 percent of the working differential pressure.
  - 2. Accuracy of 0.5 percent of calibrated span, including combined effects of linearity, hysteresis and repeatability.
  - 3. Pressure sensor shall withstand overpressure of not less than 200 percent working pressure and full vacuum underpressure without damage, changes in sensor accuracy or deformation.

## 2.10 DEW POINT AND RELATIVE HUMIDITY SENSORS

- A. Dew Point Sensors: Provide analog salt-phase transition or dual cooled mirror type sensors with an accuracy of plus or minus 3°F (1.6°C) dew point over the range of 10°F to 100°F (-12°C to 38°C) dew point.
- B. Relative Humidity Sensors: Provide analog precision resistance or hydro-mechanical gauge type relative humidity sensors, with an accuracy of plus or minus 2 percent of relative humidity over a range of 10 to 90 percent relative humidity.
- C. Shields: Provide 316 stainless steel weatherhoods and shields to protect outdoor sensors from sunlight, snow, ice, wind and rain and provide fan powered aspirator complete with wiring if recommended by the manufacturer.
- D. Indoor Covers: Sensors located in public spaces shall have brushed 16 gauge (1.6 mm) 316 stainless steel covers or recessed aspirating boxes with Allen head screw mounting plate.

## 2.11 THERMOSTATS

- A. Types: Provide electronic thermostats which operate in an analog proportional or binary two-position mode as required by the sequence of operation.
- B. Mounting: Mount thermostats in non-public spaces except room thermostats.
- C. Electric Analog Thermostats: Provide electric analog thermostat with the following characteristics:
  - 1. Sensor shall be of the bulb or capillary type which shall actuate a 135 ohm 3-wire potentiometer for 0-10 VDC, or 4-20 milliamp proportioning control action of balanced bridge motor actuators.
  - 2. Sensor shall have adjustable setpoint range of not less than 80°F (27°C) throughout the range of 0°F to plus 250°F (-18°C to plus 121°C).
  - 3. Adjustable proportional band ranges from 3°F to 25°F (-16°C to -4°C) and capillary length of not less than 5 feet (1500 mm) shall be provided.
- D. Electric Two Position Duct and Immersion Thermostats: Provide thermostats with bimetal or bulb and capillary type sensor actuating one or more switching contacts.
  - 1. Contact shall be rated for the imposed load or shall be a pilot duty type and provided with a control relay.
  - 2. Thermostats shall have adjustable setpoint throughout the range 0°F to plus 250°F (-18°C to plus 124°C).
  - 3. Fixed differential thermostats with differentials of 3 may be provided for On-Off control of unit heaters, ventilating fans and similar applications.
  - 4. Provide capillary tubes in the 5 to 20 feet (1500 to 6000 mm) lengths to suit applications.
- E. Freeze Protection Thermostats: Electric freeze protection thermostats shall be provided with capillary elements, and special purpose insertion elements not less than 20 feet (6000 mm) in length for the face of coils up to 80 square feet (7.4 m<sup>2</sup>). Freeze protection thermostats shall have the following characteristics:
  - 1. A freezing condition at any one foot length increment anywhere along the sensing element shall activate the thermostatic switch.
  - 2. Switch shall require manual reset.
- F. Weather Shields: Provide weather shields and outside air sensing elements with the following characteristics:
  - 1. Mount elements and shields on the north face of the building or location out of direct sunlight.

2. Construct shields of 16 gauge (1.6 mm) 316 stainless steel with flanges bolted to a backplate with not less than four 1/4-inch (6 mm) diameter stainless steel bolts. Mount backplate to the building structure with expansion bolts.
3. Construct shields to inhibit solar effects. Construct shields in a rectangular box configuration with ventilating raintight louvers to preclude the entrance of snow, ice and rain. Design for crossflow and vertical air circulation.
4. Mount shields accessible for maintenance.
5. Seal wall penetration watertight.

#### 2.12 SPACE THERMOSTAT (NETWORK ENABLED)

- A. Occupied spaces shall be provided with DDC network enabled, communicating, zoning thermostats. Shall have: user touchscreen display, temperature setpoint and occupancy override; and CO<sub>2</sub>, RH, and Temperature.
  1. Provide SmartX Living Space Sensor / Zone Controller or equivalent to match thermostats installed in the OPACY Warehouse, example model #s below.
    - a. Model SXWSCDXSELXX for sequences not requiring occupancy sensors
    - b. Model SXWSCDPSELXX for sequences requiring occupancy sensors.

#### 2.13 PRESSURE CONTROLLERS

- A. Types: Provide electric electronic pressure controllers of the analog or two-position type as required by the sequence of operation.
- B. Analog Controllers: Provide controllers with proportional action plus integral and derivative control modes.
  1. Provide sensing elements of the differential type measuring controlled medium and standard reference pressures.
  2. Air static pressure controllers shall have slack diaphragms with standard ranges 0 to 6 inches water column (0 to 1500 Pa) and an adjustable proportional band range of 0.02 to 0.5 inches water column (5 to 125 Pa).
  3. Sensing elements for duct applications shall be damped to preclude pulsation.
  4. Water differential pressure controllers shall have a minimum range of 0 to 50 psig (0 to 345 kPa) or 0 to 250 psig (0 to 1725 kPa) as required by the



application with adjustable proportional band of one to 25 psig (170 kPa). Sensing elements shall be diaphragm type with 3-valve manifold. Provide siphons and pressure snubbers.

## 2.14 ELECTRIC PRESSURE SWITCHES

- A. Type: Provide bourdon tube or diaphragm type electric pressure switches with tamperproof adjustable set point and differential settings. Design switches for 200 percent overpressure and full vacuum underpressure without damage or accuracy impairment.

## 2.15 AUTOMATIC DAMPERS (Not used, see General Scope Section below)

- A. General Scope: Damper replacement not included in base scope, only actuators are. However, if a damper is found to require replacement, the contractor shall provide submit an RFI for Owner and Engineer review. If damper replacement is approved, the following damper section shall be applicable.
- B. Standards: Provide opposed blade and parallel blade factory fabricated dampers of extruded aluminum, galvanized steel or stainless steel with metallic anti-friction non-ferrous bearing in accordance with Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) standards.
- C. Types: Use parallel blade dampers in mixing chambers and plenums. Use opposed blade dampers for volume control, face and bypass dampers, smoke dampers, fan discharge, and variable air volume control.
- D. Pressure Rating: For fan systems less than 10-inch water gauge (2490 Pa) static pressure, design and construct dampers to withstand a pressure of 150 pounds per square foot (7.1 kPa) without damage, leakage, flexure, or distortion.
- E. Leakage: Maximum air leakage rate for all dampers shall not exceed 10 cubic feet of air per minute per square foot (50 L/s/m<sup>2</sup>) at atmospheric pressure when closed against a 4-inch water gauge (1000 Pa) static pressure.
- F. Operators: Damper operators shall have sufficient power to open and close the dampers and limit the leakage to the specified rate. Power wiring shall be extended to operator by this contractor.
- G. Shafts and Bearings: Provide cadmium plated steel shafts in permanently lubricated bronze sleeve bearings or permanently lubricated ball bearings.
- H. Blade Sizes: Reinforced or ribbed blades shall not exceed 8 inches (200 mm) in width nor 48 inches (1200 mm) in length.
  - 1. Flat or unreinforced blades will not be acceptable.
  - 2. Damper sections exceeding 4 feet (1200 mm) in width or 4 feet (1200 mm) in height shall be constructed with multiple frames and linkages.

- I. Frames: Construct frames of factory welded galvanized steel hot dipped after construction or bolted extruded aluminum frames.
  - 1. Dampers larger than 8 square feet (.7 m<sup>2</sup>) in area shall have corner bracing gussets at each corner welded to the damper frame.
- J. Linkages: Provide linkages to uniformly transmit damper operating forces to each damper blade.
  - 1. Construct linkages of galvanized or cadmium plated steel or stainless steel.
  - 2. Bearings and joints shall be ball and socket or sleeve bearings of brass, bronze or stainless steel, with plated bolts and locking nuts.
- K. Seals: Provide mechanically attached elastomer or neoprene blade tip seal along the full length of each blade edge and flexible stainless steel seals along damper blade ends where the blades abut the frame. Adhesives or staples will not be acceptable.
- L. Damper Mounting: Mount dampers to casings and ductwork in conformance with SMACNA standards. Provide welded or bolted galvanized steel structural supports for dampers larger than 20 square feet (1.9 m<sup>2</sup>). Through bolt damper frames to structural supports.

## 2.16 AUTOMATIC VALVES

- A. Standards: For chilled water, low temperature hot water and low pressure steam provide valves conforming to ANSI B16.15, "Cast Bronze Threaded Fittings," Class 125 copper bearing steel, bronze, or ANSI B16.1, "Cast Iron Pipe Flanges and Flanged Fittings," Class 125 cast iron. For high temperature water, steam above 25 pounds per square inch (170 kPa) and water above 100 pounds per square inch (690 kPa) provide valves conforming to ANSI B16.5, "Pipe Flanges and Flanged Fittings," cast steel or stainless steel. Select valve pressure class minimum 150 percent of maximum working pressure.
- B. End Connections: Provide valves with end connections as follows:
  - 1. For chilled water, low temperature hot water and low pressure steam provide valves with flanged connections on sizes 2-1/2 inches (65 mm) and larger and threaded connections on valves 2 inches (50 mm) and smaller.
  - 2. For high pressure steam provide flange or union connections on valves 1-1/2-inch (40 mm) and larger.
- C. Small Water Valves (1" and Smaller): For valves controlling low pressure and low temperature chilled or hot water sizes one inch and smaller, bodies shall be bronze, cast iron or stainless steel with screwed, union or flare connections.
- D. Valve Trim: Provide valve trim as follows:

1. Stems shall be 316 stainless steel.
  2. Disk and stuffing boxes may be bronze or 316 stainless steel.
  3. For all valves 1-1/2-inch (40 mm) and larger, stems, disks, and seats shall be 316 stainless steel.
  4. All non-metallic parts of hot water and steam valves shall be designed for minimum 250°F (121°C) or 100°F (38°C) above system design temperature.
  5. Leakage: Control valves shall provide tight shut off in the closed position at 150 percent of maximum working pressure.
- E. Valve Characteristics: Select valves to provide equal percentage control of water and linear control of steam. Modulating valves for steam shall have V-port skirts, tapered plugs for water.
1. Butterfly valves that do not have "equal flow characteristics" will not be acceptable for modulating control.
  2. For two-position, water application action, butterfly valves may be used, provided the differential pressure across the valve does not exceed 25 pounds per square inch (170 kPa).
- F. Sizing: Provide valves of sizes indicated, or as herein specified.
1. Size steam valves with a pressure drop not to exceed 50 percent of the total differential between supply and return main at full indicated flow.
  2. Size water valves with a maximum differential pressure not greater 10 feet (480 Pa) or 1/2 the loss through the controlled apparatus, whichever is greater.
- G. Actuators: Provide actuators, sized by the manufacturer, of sufficient size and power to operate the valve under all conditions and to close the valve tight against maximum differential pressure.
1. Provide pilots for sequence operations, and cases where valve spring ranges have been increased to close off against system pressure.
  2. Comply with requirements of "Actuators" paragraph of this Section.

## 2.17 ELECTRIC ACTUATORS

- A. General: Provide electric motor driven actuators (operators) arranged "Fail Safe" in the event of power failure. Unless indicated otherwise, the fail position of each valve shall be the "last position" or "current position" at the time of failure. Design operators to be quiet in operation and function within a range 85 to 100 percent input power potential.

- B. Electric Actuators: Provide hydraulic or gear type electric actuators.
1. When operated at rated voltage each actuator shall deliver the torque required for continuous uniform movement of the control device from limit to limit.
  2. Provide an end switch to limit travel and design the actuator to continuously stroke without damage.
  3. Operators shall function properly within a range of 85 to 120 percent of line voltage. For actuators with input power greater than 100 watts, gears shall be ground steel, oil immersed, shaft shall be hardened steel running in bronze, copper alloy or ball bearing and operator and gear trains shall be totally enclosed in dustproof cast iron, cast steel or cast aluminum housing.
  4. Actuators with input power less than 100 watts may use fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings and pressed steel enclosures.
  5. Two position actuators shall be of the single direction, spring return or reversing type.
  6. Proportioning operators shall be capable of stopping at all points in the cycle and starting in either direction from any point.
  7. Reversing and proportioning operators shall have limit switches to limit travel in either direction.
- C. Damper Operator Mounting: Mount damper operators where accessible for maintenance.
1. If located outside the duct or casing, mount operators on a 14 gauge (2.0 mm) reinforced support plate arranged to allow insulation between the support plate and the face of the duct or casing.
  2. Brace damper operators rigid to show no deflection or movement over the full range of the damper stroke.

## 2.18 CONTROL PANELS AND CABINETS

- A. Local Panels and Cabinets: Provide local control cabinets for each air handling unit, automatically controlled equipment such as pumps, fans, heaters and convertors, or groups of such equipment in a single mechanical equipment room.
- B. Standards: Construct panels in conformance with UL 50, "Cabinets and Boxes," or similar approved construction, with backbox, full-sized piano hinged face, stainless steel lockable latch, and secure to the building construction.

1. Internally mount all controllers, relays, terminal boards, and miscellaneous control devices, on a removable panel.
2. Flush mount in the door all indicators, selector switches, remote setpoint adjusters, and pilot lights.
3. Cabinet internals may be factory or field wired and piped. Wire shall be neat, braced, and strapped flat to present a neat appearance and to easily trace wiring and piping from one device to another.
4. Floor mounted panels shall be bolted to 1-1/2-inch by 1-1/2-inch (40 mm by 40 mm) structural support channel, bolted to the floor and braced at the top.

## 2.19 SYSTEM DIAGRAMS

- A. Mounting: Mount control diagrams adjacent to each local control panel on a furniture steel extension either bolted to wall or to an extension of the control cabinet structural support.
  1. Control diagrams shall include system one-line diagram, system control diagram, sequence of operations, and schedule of control devices.
  2. Diagrams shall be hermetically sealed in laminated 16 gauge (1.6 mm) plastic.
  3. Diagrams shall be permanent, black on white background, not subject to fading when subjected to artificial or natural light. Diazo prints are not acceptable.
  4. Diagrams shall represent the current, "as-built" status of the control system, after acceptance by the representative of the Owner.
  5. Obsolete, out of date, or field modified diagrams shall be removed, and new current diagrams furnished.
  6. Diagrams and devices on local control panels shall be identified with engraved phenolic nameplates, white on black, minimum 1/4-inch (6 mm) high block capital lettering, screwed or bolted to panel or mounting plate face. Adhesive attachments are not acceptable.

## 2.20 WIRING

- A. General: Provide a complete system of electric wiring for temperature control apparatus including control power transformers and wiring to the transformer primary.
- B. All wiring shall be installed in conduit. Refer to Division-26 section, "Raceways." MC cable is prohibited in all locations.

- C. Wiring: Wire for low voltage AC shall be minimum 300 volt insulated copper No. 18 AWG or larger conforming to NFPA 70, Type MTW, THHN or TFFN, installed in accordance with Division-26 of these specifications.
  - 1. For low voltage DC and an electronic circuit carrying less than 0.5 amperes, cables of two or more conductors not smaller than No. 18 AWG solid copper or No. 18 AWG solid copper if not shielded may be used in lieu of individual wires.
  - 2. Cables carrying analog signals shall be shielded, if required by the manufacturer.
  - 3. Cables shall be terminated in solder or screw type terminal strips.
  - 4. Cables shall not be tapped at any intermediate points.
  - 5. All wire shall be color coded or numbered for identification. Identify as indicated on shop drawings and "as-built" drawings.
  - 6. Wire terminating in screw type terminal strips shall have pressure connectors conforming to UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," or UL 486B, "Wire Connectors for Use with Aluminum Conductors."
  - 7. Wire terminations without connectors or traveling pressure pads will not be accepted.
- D. Network Cable shall be CAT 6 and "Orange"
- E. The contractor shall in no case combine control wiring (line or low voltage) with power wiring in the same conduit.

#### 2.21 ACCESSORIES

- A. Provide two (2) PC based operator's workstations within the building at a locations determined by the owner, including a flat screen monitor (minimum 21") and a color laser printer. Provide color graphics of all systems to be controlled, monitored and alarmed by the EMCS. Computer hardware and software shall be compatible with the most current version of the ATC vendor's software and graphics packages.
- B. Provide a portable operating terminal for connection to the main DDC control panel. In addition, main panel shall be provided with modem connection.

#### 2.22 FLOW SENSORS

- A. General: Provide sensors for measuring flow in piping and ductwork that are compatible with static pressure and differential pressure analog of the electronic controllers served.

- B. Turndown: Provide sensors with an output characteristic which gives a continuous mathematical function over the full range of flow from maximum to minimum required.
- C. See specifications, this section, for required air and/or water flow monitor measurement characteristics.
- D. Provide all necessary power and control wiring as required for complete and operational flow measurement systems interlocked with the building EMCS.

## 2.23 AIRFLOW MEASUREMENT SYSTEMS (AIRFLOW MONITORS)

- A. The airflow measurement system (AFMS), including airflow monitor, sensors, controllers, transmitters, etc., indicated on the plans shall be capable of continuously monitoring airflow rates at each measurement location. The system shall consist of one or more airflow measuring devices and a single microprocessor based transmitter. The number of sensing points shall be as per manufacturer's recommendation for the specified application. The AFMS shall not require recalibration or adjustment over the life of the equipment. If the technology provided is vortex shedding or the pitot tube type the system shall be calibrated on a semi-annual basis during the construction phase through the end of the warranty. The manufacturer is responsible for all cost associated with recalibration.
- B. Upon request, the manufacturer shall provide for approval and verification a written copy of the following:
  - 1. 16 point NIST traceable report of calibration used for the reference standard.
  - 2. UL/cUL 873 report listing the AFMS as a complete assembly.
  - 3. Independent laboratory test report results of 100% survival rate in a 30 day saltwater and acid vapor test.
- C. The AFMS shall produce a single, linear, analog output signal for airflow, which can be measured by the host control system. The system shall have the ability to perform self-diagnostics and automatic zeroing to adjust the signal to zero at pre-determined time intervals, which eliminates all output signal drift due to thermal, electronic and mechanical effects. In the event of sensor failure, the system shall ignore the failed sensor(s), average the remaining sensors and continue to operate.
- D. The total accuracy from the airflow measurement to the host controls, including sensing point averaging error, the sum of the sensor and electronic (transmitter) errors, etc. shall not exceed +/-2% of reading at both minimum and maximum airflow rates based on the manufacturer's published performance specifications for all devices. In addition, total system performance including sampling error, shall not exceed +/-5% of actual airflow. The installed accuracy, in accordance with manufacturer's recommendations, without field adjustment shall be as follows throughout the operating range:

1. Ducts and plenums: +/- 3% of reading
  2. Outside air intakes: +/-5% of reading
  3. Fan inlets: +/- 10% of reading
- E. The sensors and electronics shall operate over a temperature range of -20 to 120°F for ducted supply or return applications and -20 to 120°F for outside air applications. The sensors and electronics shall operate at a relative humidity range of 0 to 95% (non-condensing) for ducted supply and return applications and 0-99% (non-condensing) for outside air applications. Each sensor node shall be individually calibrated at 16 measurement points to airflow standards directly calibrated at NIST to the NIST Laser Doppler Anemometer (LDA) primary velocity standard and have an accuracy of  $\pm 2\%$  of reading over the entire calibrated airflow range of 0 to 5,000 FPM for ducted applications. Upon request, a working demos shall be provided to the design team to display that the system can work at low flows.
- F. For standard applications, sensors shall be constructed of materials that resist corrosion due to moisture or salt in the airstream. Aluminum probes shall be provided. For laboratory exhaust applications, provide stainless steel sensors with stainless steel casing. Each sensor probe shall be provided with an integral, FEP jacket, plenum rated CMP/2CL2P, UL/cUL listed cable rated for exposures from -67°F to 392°F (-55°C to 200°C) and continuous and direct UV exposure. Plenum rated PVC jacket cables are not acceptable. Devices that have electronic signal processing components on or in the sensor probe are not acceptable. Where the electronics are installed in a location exposed to potential wind driven rain or snow (including outside air plenum) provide a NEMA 4 enclosure for all electronics. In addition, a visual display shall be provided to illustrate airflow (CFM) and temperature. The transmitter must also be able to display individual sensor reading and each individual flow for each fan on a fan array.
- G. Analog signal capability shall include two output terminals: the first (AO1), shall provide the total airflow rate; while the second output (AO2) shall be field configurable to provide one of the following: temperature, low and/or high airflow user-defined set point alarm, individual fan alarm (for fan arrays) or system status alarm.
- H. Airflow measuring devices shall be UL listed as an entire assembly. The transmitter shall include fused protection.
- I. The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans for conformance with installed accuracy requirements. A written report shall be submitted to the consulting mechanical engineer if any measurement locations will not result in specified installed accuracy requirements.
- J. Prior to purchase or installation of the air flow monitor (AFM), the Contractor and/or AFM Product Representative shall review each equipment and/or duct mounted location to verify suitability for installation. Should there be any



discrepancy regarding installation or performance, the Contractor shall notify the Engineer immediately.

- K. Provide all necessary power and control wiring as required for a complete and operational air flow measurement system interlocked with the building EMCS. Network communications RS 485 (BACnet MS/TP or Modbus RTU) or Ethernet (BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) shall provide: the average airflow rate, temperature, high and/or low airflow set point alarm, system status alarm, individual sensor node airflow rates (individual fan airflow rates for fan arrays) and individual sensor node temperatures.
- L. Airflow measurement system manufacturers shall be limited to the following:
  - 1. Ebtron (Gold)
  - 2. Air Monitor Valo-probe with Veltron II transmitter
  - 3. Tek Aire Vortek VT-5000

## 2.24 FLOW METER

- A. Furnish and install flow meters where indicated on the drawings. Flow meter shall be a dual turbine insertion type flow sensor complete with all installation hardware necessary to enable insertion and removal of the flow meter without system shutdown. The dual turbine element shall have contra-rotating axial turbine elements, each with its own rotational sensing system, and an averaging circuit to reduce measurement errors due to swirl and flow profile distortion. Paddle type rotors will not be acceptable. Rotational sensing of each turbine shall be accomplished electronically by sensing impedance change and not with magnetic or photo-electric means.
- B. The sensor shall have a maximum operating pressure of 400 PSI, minimum operating pressure of 180°F (optional 300°F peak) and a pressure drop of less than 1 PSI at 17 feet per second flow velocity. Flow sensor shall have a 175:1 turndown ratio. Accuracy shall be  $\pm 0.5\%$  of actual reading at the calibrated typical velocity, and within  $\pm 2\%$  of reading from 0.4 to 20 ft/s (50:1 turndown). Each sensor shall be individually wet calibrated and tagged accordingly against a primary volumetric standard accurate to within 0.1% and directly traceable to the U.S. National Institute of Standards and Technology (NIST).
- C. The sensor shall have integral analog outputs of 0-10 VDC and 4-20 mA linear to within  $\pm 0.1\%$  of calibrated span for connection to the EMCS. The sensor shall also include three (3) integral frequency outputs (top turbine, bottom turbine, average frequency) for diagnostic purposes and for connection to peripheral equipment (local display, BTU meter, etc.). All outputs shall be linear with flow rate.
- D. The turbine elements shall be constructed of polypropylene (optional polysulfone) with sapphire jewel bearings and tungsten carbide shafts. The flow sensor shall be

constructed of plated brass (optional 316 stainless steel with an aluminum electronics enclosure and gasketed cover) (optional weathertight enclosure).

- E. Flow meter shall be Model F-1210 as manufactured by Onicon or equivalent.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Wiring and Conduit: Provide wiring and conduit to connect the automatic control system components for an operational system.
1. Provide wiring in accordance with requirements indicated in this section.
  2. Run conduit in straight lines, parallel to the lines of the building, and rack on factory furnished mounting blocks attached to the building structure. Where run buried in slabs provide long sweep rigid conduit bends extending 6 inches (150 mm) above the slab at slab penetrations.
  3. Do not bury or conceal wiring beneath building insulation.
  4. Locate wiring clear of access doors, accessible ceilings, lighting fixtures, walkways, or any location subject to damage or abrasion.
  5. Existing conduit may be reused if in good condition and will not cause conflict with phasing of work.
- B. Identification: Label or code each field wire at each end, and each controller and controlled device.
1. Identification shall be permanent, robust, not subject to fading, and flameproof.
  2. Permanently mark terminal blocks at wire termination points.
  3. Identify each control device with an engraved laminated phenolic nameplate, white on black, lettering not less than 1/8-inch (3 mm) height, on 1-1/2-inch (40 mm) by 1-inch (25 mm) tag and brass interlocked chain secured to the control device. Name shall correspond with identification on the shop drawings.
  4. Identify sensors, controllers, relays, either mounted in local or central control panels, or remote mounted with a similar name tag as specified above. Attach to or adjacent to controllers with stainless steel or brass screws or rivets. Adhesives will not be acceptable. Do not attach to removable controller covers.
- C. Pipe Work: Mount strap-on sensors using helical screw stainless steel band clamp for strap-on thermostats, aquastats and other temperature switches on new piping for unit heaters and fan coil units after the pipe is cleaned to bright metal. Strap-on

sensor may be used on piping up to 2-1/2-inch (65 mm) diameter. On pipe 3 inches (80 mm) and larger use pipe wells.

- D. Pipe Wells: Install pipe wells above the horizontal to retain liquid heat transfer fluid in the well.
- E. Valves: Install valves in piping with stems as vertical as possible but in no case less than 45 degrees from vertical. For soldered or welded connections, remove valve internals before mounting.
- F. Electric Valves: Wire electric valves in accordance with NFPA 70 with not less than 2 feet (610 mm) of flexible liquidtight connector with watertight bushings at the valve actuator. Brace conduit to the building structure.
- G. Pressure and Temperature Sensors: Install pressure and temperature sensors as follows.
  - 1. Locate pressure and temperature sensing points sufficiently downstream from the control device to increase control loop time constant and minimize hunting.
  - 2. Locate shut-off valves and 3-valve bypasses as specified in "Sensors" paragraph of this Section.
  - 3. Locate sensors where accessible for maintenance and replacement.
  - 4. Do not cover or conceal sensors with insulation.
- H. Space Sensors: Install space sensors as follows.
  - 1. Provide space thermostat with digital display in all occupied spaces. Thermostat adjustment shall be set and locked-out through the BAS (default).
  - 2. Locate room thermostats and other room sensors approximately 48 inches (1200 mm) above the floor (or otherwise as required to meet the most current ADA guidelines) on inside wall where they will respond to average conditions in the space. All locations shall be field verified and coordinated with owner.
  - 3. Sensors mounted on outside walls, if unavoidable, shall be mounted on factory made insulated brushed stainless steel bases.
  - 4. Provide thermostat/sensor guards (total quantity of 15) where directed by the owner. Thermostat/sensor guards shall be clear, impact resistant lockable plastic or approved equivalent.

- I. Air Handling Unit Temperature Indicators: For each factory assembled central station air handling unit and field erected air handling unit, provide temperature indicators in the following locations. In addition, unless indicated otherwise by the Owner, provide thermostat/sensor guards wherever students have access, including but not limited to: classrooms, corridors, cafeteria, media center, auditorium, etc.
  1. Each outside air plenum.
  2. Each return air plenum.
  3. Each cooling coil inlet and discharge.
  4. Each heating coil discharge.
  5. Temperature indicators shall be so located that they may be read by an operator standing on the operator floor. Indicators more than 8 feet (2400 mm) above the floor shall be remote bulb type.
- J. Duct Sensors: Select duct sensor locations to properly sense average air conditions, minimize vibration, avoid dead air spaces, and within velocity limits required by the manufacturer.
  1. Provide velocity shields where required.
  2. Securely mount or clamp averaging elements, maximum 3 feet (900 mm) on centers to the leaving side of coils and equipment. Insulate averaging elements from equipment and protect from vibration.
  3. Provide separate duct flanges for each sensing device.
  4. Provide gaskets or sealant where elements penetrate duct walls.
  5. Mount sensor to allow easy removal and servicing without disturbing insulation or vapor barrier. Mount on standoff brackets to avoid condensation.
  6. Coordinate the location for duct access doors downstream from each duct sensor.
- K. Pipe Sensors: Provide wells for all sensors and indicators measuring temperatures in pressure vessels and piping.
  1. Wells shall be stainless steel or bronze to match media requirements.
  2. Verify working pressure of sensor wells.
  3. Do not install wells in extension couplings.
  4. Where pipe diameters are smaller than the well length, provide wells at piping elbow or tees to affect flow across the entire well area.

5. Wells may face upstream or downstream.
  6. Angle wells to retain thermal fluid within the well.
  7. Should wells restrict cross sectional pipe area to less than 70 percent free area, provide pipe increases at the well not less than 150 percent pipe diameter.
- L. The ATC contractor shall interface with smoke detectors, smoke dampers and fire alarm devices as required to accomplish equipment shutdown, alarms, etc., as indicated in sequences.
- M. For single phase motors, provide relays and/or contactors of appropriate horsepower and voltage rating as required to energize/de-energize equipment as indicated in sequences.

### 3.2 TEST PLAN

- A. Test Plan: Prepare a written test plan indicating in a step-by-step, logical fashion, the procedures by which the automatic control system will be tested, adjusted, and checked.
- B. Pre-Approval: Not less than six (6) weeks prior to testing, provide four (4) copies of the proposed test plan for approval. Meet and discuss the test plan, and make agreed changes to the written plan.
- C. Content: Plan shall include, as a minimum, for each system and sub-system of the automatic control work the following:
1. System name.
  2. List of devices with brief description of functional purpose of each.
  3. A description of the expected signal values transmitted by the sensor.
  4. A description of the expected signal values transmitted by the controller to the control device or actuator.
  5. A description of the expected values of the control medium from limit-to-limit.
  6. A description of the instrumentation required to test the system.
  7. A description of the expected field adjustments for transmitter, controller, and control actuator should control parameters fall outside of expected values.
  8. A log sheet or sheets on which expected and field read values will be recorded and final field read values indicating that the system is operating in accordance with contract requirements.

### 3.3 TESTS DURING AND AFTER INSTALLATION

A. Instrumentation and Control: Calibration test each controller as follows:

1. Disconnect the sensor input signal to the controller and provide a compatible test signal generator.
2. Simulate expected transmitter values and input to the controller. Record controller branch line values.
3. Examine control device and determine that the device is responding.
4. Simulate maximum and minimum transmitter signal values and verify minimum and maximum controller output values and control device minimum and maximum stroke range.
5. Record all values and recalibrate controller as necessary to conform with specified control ramps, reset schedule, proportional relationship, reset relationship, and derivative reaction.
6. When the controller and control device portion of each loop are responding as designed, reconnect the sensor transmitter input line.
7. After mechanical equipment control becomes operational, perform an operational test of each control loop recording sensor, transmitter, controller input, controller output and control medium parameter.
8. Entire test shall be witnessed by an owner's representative.
9. Upon satisfactory test a copy of final test results shall be bound in the operating and maintenance manual.

### 3.4 FUNCTIONAL PERFORMANCE TESTING AND VERIFICATION

- A. General: In addition to the tests required during and after installation of all mechanical systems, as well as any other formal commissioning requirements, the Contractor shall perform functional performance tests to verify that all systems are designed, installed, calibrated and adjusted to perform as required in the Contract.
- B. Comply with all applicable specification sections including, but not be limited to, "Basic HVAC Requirements", "Testing, Adjusting and Balancing", "Automatic Temperature Controls" and "Commissioning", where applicable.
- C. Prior to functional performance testing, all indicating, recording and control devices shall be calibrated. A calibration verification report shall be provided with the final test report.
- D. Provide functional performance testing to verify proper operation of each and every control sequence indicated throughout the contract documents.

- E. Failure of Tests: Should any test, verification, or demonstration fail to meet the specification requirements, the component of the system causing the failure shall be repaired, replaced or readjusted. The failed test, verification, or demonstration shall then be repeated.
- F. Test Report: Upon satisfactory verification of calibration and functional performance tests, a copy of the final test results shall be bound in the operations and maintenance manual. The final report shall also include a full compliance statement, on company letterhead, indicating that all systems are installed and functioning per the contract requirements including drawings, specifications, control sequences and accepted submittals.
- G. The mechanical systems shall not be considered complete until all functional performance verification forms, calibration reports and compliance statement have been submitted and reviewed. Submit in accordance with the submittal requirements indicated elsewhere in these specifications.

### 3.5 DEMONSTRATION AND TRAINING

- A. Demonstration: After completion of testing as hereinbefore specified, provide demonstration and training of designated operating personnel (refer to Division-1).
  - 1. Demonstration shall be performed.
  - 2. Demonstration shall include the operation of the entire mechanical system under the control of the Contractor and shall include the start-up, operation, and shutdown of the system in accordance with the sequence of operation.
  - 3. The operation of each device shall be performed in accordance with the written instructions contained in the operation and maintenance manual, a copy of which shall be available ten (10) working days prior to the test. No deviation from procedures in the operating manual will be permitted.
- B. Failure to Perform: Should the system fail to perform in accordance with the requirements of the operation and maintenance manual, the system shall be repaired, recalibrated, retested as necessary, and a second demonstration performed.
  - 1. Subsequent demonstrations shall occur until the automatic control system and all associated mechanical and electrical equipment are operating in accordance with contract requirements.
  - 2. All testing, retesting, and recalibration shall be at no additional expense. The Contractor shall reimburse the expenses of the commissioning team for each test after the first.

### 3.6 INSTRUCTING OPERATING PERSONNEL

- A. Instructors and Superintendent: Upon completion of the work and acceptance by the representative of the Owner, provide the services of an Instructor to instruct designated operating personnel in the operation and maintenance of the automatic control system.
1. TRAINING: Meet all applicable Training requirements of Division 1, Division 15, and the following.
  2. Instruct the operators how to accomplish control of the system. Include basic troubleshooting and override of equipment and controls in the event of system failure.
  3. Training Allowance: Provide not less than sixteen (16) hours over not less than four (4) days of formal training to the Owner's designated operations personnel. The training hours and days are a minimum to include and final schedule shall be coordinated with the Owner. Any less hours/days shall be at the Owner's sole discretion.
  4. Trainers - Persons conducting the training shall hold an advanced certification for the installed Building Automation System, be knowledgeable in the workings of the system, and shall be regularly engaged in training exercises, so as to provide effective training. Acceptability of the trainers shall be at the discretion of the Owner.
  5. Training Manuals - Include the following in training manuals.
    - a. Manufacturer's training brochures.
    - b. Operation and maintenance manuals.
    - c. Completed Field Acceptance Test Procedure.
    - d. "As-installed" Drawings.
    - e. Manufacturer's Operation Manuals.
    - f. Software interaction sheets to be used in instructing students how to use the control system, on a command-by-command basis.
  6. Training Classes - Prior to conducting training, prepare and submit for approval the proposed training literature and topics. Submit this information at least two weeks prior to the first class.
  7. Provide approved training manuals to the Owner at least one week prior to the first class.



8. Provide Audio Visual Tutorials both in a CD format and on the manufacturer's website instructing on the operation of the programming software tools as provided under this specification.

### 3.7 BUILDING MANAGEMENT AND CONTROL SYSTEM DEVICES AND POINTS

- A. Provide all building management and ATC system controllers, devices, points, etc. as required to accomplish the control sequences and equipment functions indicated throughout the contract documents, including drawings and specifications. In addition, provide all controllers, devices, points, etc. as required to control, operate, monitor and alarm all equipment and devices indicated on the contract documents (including but not limited to: chillers, cooling towers, pumps, air handling units, fans, variable frequency drives, air volume terminal units, humidifiers, valves, dampers, flow measuring devices, sensors, etc.). All points shall be available through the Energy Management Control System (EMCS). See attached points list (where applicable).
- B. Building management and control points shall include status for all mechanical equipment with equipment failures alarmed at the EMCS. In addition, furnish and install all points required to provide complete, color, system graphics of all mechanical systems and components indicated throughout the contract documents. All equipment and devices indicated throughout the contract documents shall be indicated at the operator's workstation (where applicable) and all end devices shall be individually controlled unless specifically indicated otherwise.
- C. Building management and control system features for equipment and devices shall include, but not be limited to, the following where applicable: runtime, trend data, optimal start, scheduling, paging, system graphics, and internet access to graphic and text-based displays.

END OF SECTION 230900

## SECTION 250010 - INTELLIGENT BUILDING MANAGEMENT SYSTEM (iBMS)

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, configuration and installation for an Intelligent Building Management System (also identified as iBMS, IBMS or Integrated Building Management System) as required for the complete performance of the Work, as shown on the Drawings and as specified herein.
  - 1. Custom Reports: Provide all custom reports within the iBMS required for the owner's operation of the facility, including but not limited to: schedules, metering reports, lighting scenes, etc... Scope shall include fifty (50) custom reports.
- B. The iBMS shall be provided by a qualified iBMS system supplier (also identified as Master System Integrator or MSI). The Contractor shall ultimately be responsible for the iBMS and shall supplement the system supplier's Work as necessary to provide a complete and operable system. The Contractor shall coordinate the equipment and systems provided by others that interface with the iBMS to ensure necessary interconnections and compatibility are provided for the required functionality of the iBMS.
- C. The iBMS system supplier shall be the same as the system supplier for specification Section 23 09 00 Automatic Control Systems.
- D. The iBMS system supplier shall not duplicate Work specified under Divisions other than Division 25 but shall be responsible for the integration, communications and functionality of those systems as specified herein. This shall include the augmentation (configuration, programming, etc.) of those systems provided by others to provide the specified integrated cross-system functionality. System suppliers under Divisions other than Division 25 are required to provide their specified system functionality, system access to the iBMS system supplier for the purpose of providing the iBMS and interface coordination for the integration specified herein.
- E. Refer to the exhibits in specification Section 25 00 10 Intelligent Building Management System (iBMS) Exhibits for additional clarification of typical system supplier responsibilities by specification Division.
- F. Related Sections: Possible related sections include, but shall not be limited to, the following:
  - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

2. Applicable general requirements for HVAC Work specified within Division 23 Specification Sections including those for Common Work Results for HVAC specified within the subset of 23 05 ## specifications apply to this Section. In addition, refer to the following Division 23 specifications for additional requirements:
  - a. Section 23 09 00 Automatic Control Systems
3. Applicable general requirements for electrical Work specified within Division 26 Specification Sections including those for Common Work Results for Electrical specified within the subset of 26 05 ## specifications apply to this Section. In addition, refer to the following Division 26 specifications for additional requirements:
  - a. Section 26 09 13 Electrical Submetering System
  - b. Section 26 09 43.23 Lighting Controls
4. Applicable general requirements for Communications Work specified within Division 27 Specification Sections including those for Common Work Results for Communications specified within the subset of 27 05 ## specifications apply to this Section. In addition, refer to the following Division 27 specifications for additional requirements:
  - a. Section 27 10 00 Telecommunications Structured Cabling

## 1.2 REFERENCES

- A. General, Publications: The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.
  1. International Electrotechnical Commission (IEC)
    - a. ISO 9001, "International Organization for Standardization"
    - b. IEC 62443, "Industrial Automation and Control Systems Security"
  2. International Organization for Standardization (ISO)
    - a. ISO 9001, "Quality Management Systems - Requirements"
  3. National Fire Protection Agency (NFPA)
    - a. NFPA 70, "National Electric Code"

- b. NFPA 70E, "Standard for Electrical Safety in the Workplace"
- c. NFPA 70B, "Recommended Practice for Electrical Equipment Maintenance"
- d. NFPA 72, "National Fire Alarm and Signaling Code"
- e. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilation Systems"
- f. NFPA 90B, "Standard for the Installations of Warm Air Heating and Air Conditioning Systems"
- g. NFPA 110, "Standard for Emergency and Standby Power Systems"
- h. NFPA 101, "Life Safety Code"
- 4. Underwriters Laboratories, Inc. (UL)
  - a. UL / UUKL, "864 Smoke Control"
  - b. UL 268, "Smoke Detectors"
  - c. UL 916, "Energy Management"
- 5. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
  - a. ASHRAE 90.1-2016, "Energy Efficient Design of New Buildings"
  - b. ASHRAE 62.1-2013, "Ventilation for Acceptable Indoor Air Quality"
  - c. ASHRAE 189.1-2011, "Standard for the Design of High-Performance, Green Buildings"
  - d. ASHRAE 135-2007, "BACnet"
  - e. ASHRAE 55-2013, "Thermal Environmental Conditions for Human Occupancy"

### 1.3 DEFINITIONS

- A. Unless specifically defined within the Contract Documents, the words or acronyms contained within this specification shall be as defined within, or by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.

1. ACS: Access Control System
2. AFDD/CC: Automated Fault Detection and Diagnostics with Commissioning System
3. BM / BMS / BAS: Building Management System or Building Automation System
4. CMMS: Computerized Maintenance Management System
5. EPMS / EMS: Electrical Power Management System or Energy Management System
6. FIPS: Federal Information Processing Standards
7. FAS: Fire Alarm System
8. GUI: Graphic User Interface
9. HOA: Hand, Off, Auto Position Switch
10. iBMS / IBMS: Intelligent Building Management System
11. LCS: Lighting Control System
12. MSI: Master System Integrator / iBMS System Supplier
13. NTP: Network Time Protocol
14. NSC: Network Server Controller
15. PDU: Power Distribution Unit
16. SAAS: Software as a Service
17. SDCU: Standalone Digital Control Units
18. Smart Mobile Device: Smart phone or tablet compatible with iOS or Android OS capable of running apps used for specified functionality
19. VAV: Variable Air Volume or Variable Air Volume Box
20. WAGES: Water, Air, Gas, Electrical, Steam

#### 1.4 SUBMITTALS

- A. General: Submittals shall be in accordance with the requirements of Section 01 33 00 Submittals, in addition to those specified herein.
  1. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags

and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.

2. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.
  3. Submit required product data and shop drawings specific to each product and accessory proposed. In addition, include the following information:
    - a. System Architecture Diagram
    - b. System Network Riser Diagrams
- B. iBMS Software Configuration Standards and Conventions. A "Software Configuration Standards and Conventions" document shall be prepared and submitted by the system supplier after the first iBMS Software Configuration Review Meetings to document decisions made within the meeting. The document shall be submitted for review and comment before software configuration commences. All copies of this submittal shall be provided in color to ensure the accuracy of each item. No black and white copies will be accepted. The colors used in the printed submittal shall accurately depict the colors and shapes proposed for use on the final system.
- C. Custom Reports required under the Summary Section shall be submitted for review and approval.
1. List of Custom Reports to be included.
  2. Custom Report Templates
  3. Complete Custom Reports
- D. Operation & Maintenance (O&M) manuals shall be provided in accordance with the minimum requirements specified in Section 01 78 23 Operation and Maintenance Data and additional requirements specified herein.
1. Submit required Operations & Maintenance data specific to each product and accessory proposed. In addition, include the following information:
    - a. iBMS Sequence of Operations
    - b. Electronic configuration files for all configured devices and instructions to restore backup files.

- E. Multi-System Service Contract Proposal: The iBMS system supplier shall submit a proposal for a Multi System Service Contract for a period of 5 years to include all systems provided and integrated herein.
1. Pricing for each year shall be broken out to understand the yearly price increase based on standard economic indicators and aging equipment risk.
  2. All requirements defined in each integrated system specification(s) related to extended service shall be included within this proposal.
  3. The iBMS system supplier shall provide one point of contact for all system(s) issues and provide a listing of service response times for each system.
  4. The iBMS system supplier shall break out pricing for each year specific to any software as a service (SAAS) offerings. Also included in the pricing breakout shall be any yearly software licenses required to keep specified and proposed functionality active.

#### 1.5 QUALITY ASSURANCE

- A. System Supplier: The iBMS system supplier shall be a firm that shall have a minimum of 5 years of successful installation, configuration and integration experience with projects utilizing equipment similar in type and scope to that required for this Project. The iBMS system supplier shall be certified for configuration of the building management system of specification Section 23 09 00 Automatic Control Systems (Electric-Electronic) by the manufacturer's representative.
- B. The iBMS system supplier shall provide specified products of types and sized required from manufacturer(s) whose products have been in satisfactory use in similar service for a minimum of 8 years.
- C. iBMS Software Configuration Review Meetings
1. Prior to executing Work associated with configuring the software and functional requirements specified herein the Contractor shall schedule an iBMS Software Configuration Review Meeting between the iBMS system supplier, the system suppliers of the systems being integrated at the Owner's facilities. The purpose of this meeting shall be to coordinate and ensure the following between systems:
    - a. GUI conventions
    - b. Report formats
    - c. System coordination
  2. The iBMS system supplier shall provide a project specific example of a specified application functional requirement in the production

environment that shows all sequences and proposed GUI conventions for review prior to commencing work on the remaining applications of the system.

3. The Contractor shall schedule a second meeting at the Owner's facilities to review each specified application functional requirement(s) in the production environment and correct prior to onsite installation.

- D. All work performed and all materials used shall be in accordance with the National Electrical Code and with applicable local regulations and ordinances. Equipment assemblies, materials, and equipment shall be listed and labeled by Underwriter's Laboratories or by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Prior to delivery to the Project site, ensure that suitable storage space is available to store materials in a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres. Materials shall be protected during delivery and storage and shall not exceed the manufacturer stated storage requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. In addition, protect electronics from all forms of electrical and magnetic energy that could reasonably cause damage.
- B. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified within the Contract Documents.
- C. Inspect and report any concealed damage or violation of delivery storage, and handling requirements to the Engineer.

#### 1.7 WARRANTY

- A. General: Refer to Section 01 77 00 - Closeout Procedures.
- B. The manufacturer shall warrant products against defects in material and workmanship for 12 months from the date of commissioning or 18 months from the date of shipment – whichever comes first. During the warranty period the manufacturer shall repair or replace defective products. This warranty shall be in addition to any provided by the Contractor. The warranty shall exclude normal wear and tear under normal usage and any damage caused by abuse, modification, or improper maintenance by entities other than the manufacturer or its approved representative.
- C. Additional Owner Rights: The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.



## 1.8 SPECIAL TOOLS AND SPARE PARTS

- A. The Contractor shall provide a recommended spare parts list with the following information provided as a minimum:
  - 1. Contact information for the closest parts stocking location to the Owner.
  - 2. Critical spare parts shall be identified as those parts being associated with long lead times and/or those being critical to the unit's operation.
  - 3. Maintenance spares shall be identified as being those parts required to regularly perform scheduled maintenance on the furnished equipment. These spares shall include, but shall not be limited to, consumable spares that are required to be exchanged during scheduled maintenance periods.
- B. Spare parts shall be provided for each type and size of unit installed. At a minimum, the following shall be provided:
  - 1. Provide the minimum spare parts recommended by the manufacturer.
- C. Any System Supplier specific special tool, not normally found in an electrician's toolbox, required to remove and install recommended or furnished spare parts shall be furnished. At a minimum the following shall be provided:
- D. Any System Supplier specific special tool, not normally found in an electrician's toolbox, required to remove and install recommended or furnished spare parts shall be furnished. At a minimum the following shall be provided:
  - 1. System Supplier shall provide PC-based computer configuration software or smart mobile device App tool and a minimum of one communication interface cable for each type of cable required to connect the computer/device to the devices specified herein for configuration and programming.
  - 2. Electronic configuration files, in a media format acceptable by the Owner (e.g. CD, USB stick, etc.), updated to an as-installed and commissioned state.
- E. Spare parts shall be properly marked and packaged for long term storage. Printed circuit boards shall be provided in separate anti-static containers.

## PART 2 - PRODUCTS

### 2.1 INTEGRATED SYSTEM ARCHITECTURE.

- A. Prior to bidding, the Contractor shall ensure that the Project architecture of the iBMS specified herein and that of the systems integrated specified under other Divisions are a validated system architecture of the manufacture(s) of those systems. The Contractor shall list the iBMS system supplier and the manufacture(s) of the systems to be integrated on the bid form.

- B. Basis-of-Design Architecture: Subject to compliance with requirements, provide architectures for integrated intelligent building management systems by one of the following pre-qualified manufacturers:
  - 1. EcoStruxure Building Management platform as developed by Schneider Electric.
  - 2. Niagara 4 Framework platform as developed by the Tridium Corporation.
- C. Intelligent Building Management System (iBMS) specified herein shall be provided by a single system supplier. Systems, products and manufacturers specified are to establish a standard of quality for design, function, materials, and appearance. Products shall be modified as necessary for compliance with requirements. Provide the specified product and manufacturer without exception, unless allowed as a substitute per the general provisions of the Contract.
- D. The architecture of the iBMS provided by the system supplier shall be based on using the building management system of specification section 23 09 00 Automatic Control Systems (Electric-Electronic) as the foundation for integrating systems and as the primary GUI interface to the user.

## 2.2 GENERAL REQUIREMENTS

- A. General Communication Protocols and Sub-System Interface Performance Requirements:
  - 1. Integration between systems shall be run on a computing environment that will auto start the integration when recovering from a power outage. Upon restart of any integration software host device, a manual user logon and authentication shall not be required to occur at the system nor network domain level for the interface to function in normal mode.
  - 2. Watchdog functionality shall be built that tests the system-to-system communication and business functionality at least every five minutes and will alarm in the iBMS if communication fails. Watchdog alarms shall be emailed to a designated list of recipients within 60 seconds of not receiving the test transactions from the iBMS.
  - 3. Any core system functionality within the iBMS shall have the following abilities:
    - a. Browse the list of objects and attributes available via web services from other core systems.
    - b. Consume information via web services from other core systems.
    - c. View and acknowledge active alarms via web services from other core systems.

- d. Consume historical Log information via web services from other core systems.
- 4. Data exchange shall be based on the Change of Value (COV) or upon request to limit network traffic and provide data responsiveness.
- B. Time Series Data Logging – Buildings and Business Analytics Requirements:
  - 1. iBMS Data Storage Server (DSS) and reporting capability shall be provided with the ability to store and query large volumes of data. This shall include trends over long periods of time to compare values such as indoor and outdoor environment conditions, equipment status and energy utilization.
  - 2. It shall be possible for the iBMS DSS to store large quantities of timed sequenced records limited only by the capacity of the storage media.
  - 3. Data from the DSS shall be available for copy within the building premises, corporate data storage or compatible cloud storage validated and approved for use by the iBMS system integrator.
  - 4. The quantity of data points which can be stored on the DSS shall only be equal to the number of objects that are defined on the BMS NSC and STCU building management system as specified in Section 23 09 00 Automatic Control Systems (Electric-Electronic).
  - 5. The DSS shall be capable of storing data from subsystems integrated to the iBMS.
  - 6. It shall be possible to capture any point data value at 5 minute intervals and store the data for a minimum of 5 years.
  - 7. Postgres SQL compatible analytical and reporting tools including but not limited to; Azure Analytics, “R”, Jaspersoft, Qlik and Tableau shall be able to access and analyze data from the DSS.
- C. Cyber Security Requirements:
  - 1. Intelligent Building Management System software cyber security requirements:
    - a. The iBMS shall be developed using secure development life cycle best practices for software development.
    - b. The iBMS shall be subjected to regular and verifiable best practice cyber security testing by the system supplier. Results of this testing shall be made available upon request prior to deployment of the system.

- c. The iBMS system supplier shall provide cyber security service incident escalation through help desk on a 7/24/365 basis.
- d. All iBMS server level devices shall require access via HTTPS.
- e. All iBMS AS shall support SNMP V3 monitoring of network performance and stack statistics for the purpose of managing denial of service attacks.
- f. The iBMS shall support the feature to auto logoff any logon that has had no activity for a predefined period of time.
- g. The iBMS shall support the feature to alarm on a predetermined period of time until the default password for each device is changed from the default factory setting.
- h. The iBMS shall support encrypted password authentication for all web services whether serving or consuming.
- i. The iBMS shall support single sign on allowing user authentication information to be shared from one trusted system to another. All cyber security standards and practices shall apply to secure the single sign on.
- j. The iBMS shall support Active Directory.
- k. The iBMS shall support password rules required by good security practices to include: password complexity, password history, minimum password length, password age, forced password change, invalid login alert, auto lock out after three invalid attempts.

2. Secure network environment requirements:

- a. The iBMS network level servers shall support encryption standard throughout the network without.

2.3 INTEGRATED BUILDING NETWORK

- A. The iBMS system supplier shall provide an integrated building network for the iBMS to include connections to workstations, webstations and servers of the iBMS, as well as, connections to subnetworks of systems being integrated. Each system to be integrated shall be responsible for its own network communications to provide its specified functionality including an acceptable network interface to the iBMS integrated building network.
- B. The integrated building network shall enable the Intelligent Building Management System (iBMS) to connect to the following subsystems (as applicable):
  - 1. iBMS Control Panels

2. iBMS Server(s)
  3. iBMS Workstation(s)
  4. Electric Meters
  5. Power Monitoring Server(s)
  6. Electrical Distribution Panels
  7. Lighting Control Panels
  8. Lighting Control Server
  9. Fire Alarm Network Interface
  10. Firewall Interface
  11. IT Network SNMP Monitoring Host
- C. Include racks or network cabinets as required by the drawings or as required by project plans. Racks shall have PDU's and local UPS Backup.
- D. Network switches shall be layer 3 managed type switches, Cisco Model IE 2000/4000/4010 or equivalent either ethernet or fiber / ethernet as required.
- E. Cyber Security:
1. The iBMS shall meet all applicable requirements of IEC 62443.
  2. The Integrated Building Network shall be protected from the outside world via configurable firewalls at each point of internet or corporate network connection.
  3. Different subsystems of the Intelligent Building Management System shall be configured on separate VLANs provided by the iBMS Owner.
  4. VLANs shall separate all tenant's systems from shell and core systems. Ports on the layer 3 network switches shall be configured to allow the transfer of necessary data between tenant and landlord shell and core systems.
  5. The ports on the firewall shall be configured to only allow the required information to pass through in the required direction (out of building / into building).
  6. Integrated Control System devices / controllers shall be cyber security tested to ensure the risk of a security breach is minimized.

7. VPN software shall be used for any remote access into the Intelligent Building Management System.

F. Manageability:

1. Network switches shall be layer 3 managed type switches either ethernet or fiber/ethernet as required.
2. The Integrated Building Network shall be manageable from a network management software capable of displaying network topology map, providing management, switch configuration and troubleshooting capability of all VLANs.
3. It shall be possible to configure network switches in an off-line mode inclusive of Switch Operating System, Port Assignments, VLAN Management, RSTP and DHCP Server settings. The off-line setting templates shall be downloadable to the network of switches at time of commissioning.
4. It shall be possible to back up the settings of the switches and to restore the settings to a replacement switch in the event of hardware failure.
5. It shall be possible to mirror traffic from a VLAN onto a switch port for network traffic analysis and troubleshooting.

G. Resiliency: The Integrated Building Network shall be capable of supporting RSTP (IEEE 802.1w) ring topology for network resiliency.

H. Structured Cabling

1. Refer to Division 27 Communications for structured cabling requirements.
2. All wire shall be copper and meet the minimum wire size and insulation class listed below:

<u>Wire Class</u>	<u>Wire Size</u>	<u>Isolation Class</u>
Power	12 Gauge	600 Volt
Class One	14 Gauge Std.	600 Volt
Class Two	18 Gauge Std.	300 Volt
Class Three	22 Gauge Std.	300 Volt
Communications	per mfr.	per mfr.

3. Communication and signal circuit used for integration shall not be installed in the same conduit as lighting or power circuits.
4. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.

5. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum  $\frac{3}{4}$  inch galvanized EMT. Set screw fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit seal-off fittings where exterior conduits enter the building or between areas of high temperature/moisture differential, and also for any room that requires ventilation pressure differential.
6. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.
7. Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location junction boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.
8. When the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings. EXCEPTION: Any wire run in suspended ceilings that is used to control outside air dampers or to connect the system to the fire management system shall be in conduit.
9. Fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140.
10. Only glass fiber is acceptable. Plastic is unacceptable.
11. Fiber optic cable shall only be installed and terminated by an experienced contractor. The iBMS system supplier shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.

#### 2.4 SYSTEM TO SYSTEM INTEGRATED LIGHTING CONTROL

- A. The iBMS system supplier shall provide the necessary Work for Integrated Lighting Control and shall include the following as required for specified functionality.
  1. Sensors matching those provided in Division 23 HVAC Division 26 Electrical and Division 28 Security where possible.
  2. Room controllers matching those provided in the Division 23 HVAC control system where possible.
  3. Interface to electrical equipment to provide lighting control.

- B. The following space parameters shall be adjustable via the room controller with a mobile occupant app or touchscreen user interface:
  - 1. Space Comfort HVAC control - Temperature Adjustment
  - 2. Lighting Control- On / Off, Presets, Raise/Lower Support
- C. The iBMS shall integrate with the networked lighting control system to override and schedule scenes, light levels, and room occupancy mode, occupied and unoccupied levels. Functionalities shall remain independent in the event of communication loss between the two systems. The iBMS shall provide the master schedule between systems.
- D. Scheduling: The iBMS shall integrate occupancy schedules from a common user scheduling system as the master schedule. This schedule occupancy information shall be used to activate automatic control sequences for comfort, wellness and energy as defined within Division 23 HVAC mechanical systems and Div. 26 Lighting Controls.
  - 1. The system integrator shall coordinate mapping of the HVAC and Lighting Control sequences, scenes and zones to ensure that the master scheduling can properly control both HVAC and Lighting seamlessly.
- E. Communication Protocols and Interfaces Performance:
  - 1. This integration shall be done via BACnet IP, Web Service API or the inherent protocol of the Intelligent Building Management System.
  - 2. If using BACnet IP, only integrations that support Device Change of Value (“COV”) Subscriptions, Description, Location, and Profile Name shall be accepted.
- F. Lighting Control Graphical User Interface:
  - 1. A graphical user interface showing floorplans with lighting control zones shall be included in the iBMS.

## 2.5 INTEGRATED ENERGY AND POWER MANAGEMENT

- A. The EPMS sub-system integrated into the iBMS per specification Section 26 09 13 shall be an ISO 50001 certified Energy Data Management System and shall facilitate building sites acquiring ISO 50001 Site Certification and maintaining ASHRAE 90-1 compliance.
- B. The EPMS sub-system software platform shall comply with cybersecurity standard IEC62443 at the component level: IEC62443-4-1 and IEC62443-4-2 (SL1) per specification Section 26 09 13.
- C. Metered energy data for utilities such as water, air, gas, electricity and steam (WAGES) from the following sub-systems shall be made available to the iBMS



via web service, Modbus, BACnet or other supported open standard communication protocols.

1. VFD drives, HVAC, and mechanical systems as specified in Division 23.
  2. Electrical circuit breakers, power/energy meters, and power quality meters from the EPMS as specified in Division 26.
- D. Integration of metered energy data with the iBMS shall provide categorization including but not limited to the following load types.
1. Lighting loads
  2. HVAC loads
  3. IT Equipment loads
  4. Ancillary electrical loads
- E. Integration of metered energy data with the iBMS shall provide categorization by the associated logical entity (such as building, facility, floor, zone, etc.) using the appropriate data tags.
- F. The following implementation details shall be specified in the “Software Configuration Standards and Conventions” document.
1. Energy metering points list for points to be integrated into the iBMS, with associated metadata tags to indicate location and load type as specified herein.
  2. Electrical quantities for each metering point in the point list including but not limited to energy per phase, real power per phase, apparent power per phase, reactive power per phase, current per phase, voltage, power factor.
- G. The iBMS must provide functionality to expose the following EPMS applications per specification Section 26 09 13.
1. Energy usage and benchmarking
  2. Energy cost allocation
  3. Utility bill verification
  4. Power quality monitoring
  5. Power events recording and analysis
- H. System Integration:

1. All direct polling of metering devices shall be done by sub-systems like EPMS and the data shall be shared with the iBMS via open protocols and web services.
2. Web interfaces to sub-systems may be exposed to the iBMS through standard web mechanisms such as HTTP and HTTPS.

### PART 3 - EXECUTION

#### 3.1 GENERAL

- A. Examine equipment exterior and interior prior to installation. Report any damage and do not install any equipment that is structurally, moisture, or mildew damaged.
- B. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
- C. Pre-Installation Conference: Prior to commencing the installation, an onsite pre-installation conference shall review the material selections, installation procedures, and coordination with other trades. Attendees shall include, but shall not be limited to, the Contractor, the Installer, manufacturer's representatives, and any trade that requires coordination with the work. Date and time of the pre-installation conference shall be acceptable to the Owner and the Engineer.
- D. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.
- E. Install equipment in accordance with reviewed product data, final shop drawings, manufacturer's written instructions and recommendations, and as indicated on the Drawings.
- F. Provide final protection and maintain conditions in a manner acceptable to the manufacturer that shall help ensure that the equipment is without damage at time of Substantial Completion.

#### 3.2 FACTORY ACCEPTANCE TESTING

- A. Factory testing shall be performed on all integrations prior to installation on site.
- B. Testing shall include a written description and block diagram describing the integration.
- C. Testing shall include the following:
  1. Functional description of the integration including intended usage.
  2. Data definition of all data elements to be transferred.

3. Data throughput performance of the data to be transferred.
4. Failure and recovery mode documentation and testing.
5. Data access and permissions for machine to machine connection set up and maintenance.
6. Review of all configuration steps needed to commission the integrations.
7. Review of all administrative tools needed to commission the integrations.
8. Review of all administration tools needed to monitor the operation performance of the integrations.
9. Cyber security analysis and testing.
10. Physical cabling and connectors required between systems prior to installation.
11. Review and test of logical network configurations including switches, routers, VLANs and network address assignment.

### 3.3 FIELD QUALITY CONTROL

- A. Functional testing, commissioning, and first parameter adjusting shall be carried out by a factory-trained manufacturer's field service representative. This manufacturer's field service technician shall provide all material, equipment, labor and technical supervision to perform inspection, testing and adjustments to ensure equipment is installed, adjusted, and tested in accordance with the manufacturer's recommendations and is ready for operation. The manufacturer's field service technician shall replace damaged or malfunctioning equipment and report to the Engineer any discrepancies or issues with the installation.
  1. The manufacturer's representative shall monitor stability of system integrations and adjust watchdog alarms sequences to limit nuisance alarms.
- B. The manufacturer's representative shall, upon satisfactory completion of inspection and testing, attach a label to all serviced devices indicating the date serviced and testing company responsible.

### 3.4 FIELD TESTING AND COMMISSIONING

- A. Operational Readiness Testing
  1. The Contractor shall inspect and test furnished equipment and associated systems for conformance to the contract documents, including equipment manufacture's recommendations, and readiness for operation. The test shall include the following as a minimum:

- a. Visually inspect for physical damage and proper installation.
  - b. Perform tests in accordance with manufacturer's instructions.
  - c. Perform tests to ensure compliance with Contract Documents.
  - d. Perform tests that equipment is ready for operation.
  - e. Touch-up paint all chips and scratches with manufacturer-supplied paint and transfer remaining paint to Owner
2. Contractor shall submit an operational readiness test report documenting all test results, including all assumptions, conditions, allowances and corrections made during the test. The report shall provide a listing of all modifications and adjustments made onsite to include any settings / parameters not identified as factory defaults within the equipment's O&M documentation. The test report shall include a signed statement from the Contractor, installer(s) and the factory-trained manufacturer's representative(s) certifying that the furnished equipment and associated system have been installed, configured, and tested in accordance with the manufacturer's recommendations, completely conforms to the requirements of the Contract Documents and is ready for operation.

B. Functional Demonstration Testing

1. Prior to scheduling functional demonstration testing the Contractor shall submit a signed statement from the Contractor, installer(s) and the factory-trained manufacturer's representative(s) certifying that the furnished equipment and associated system have been installed, configured, and tested in accordance with the manufacturer's recommendations, completely conforms to the requirements of the Contract Documents and is ready for operation.
2. The Contractor shall demonstrate the functionality and performance of the equipment and associated systems in the presence of Owner and Engineer, observing and documenting complete compliance with the Contract Documents.
3. The Contractor shall demonstrate all critical applications and shall demonstrate all other applications to validate proper configuration and object naming. If during that trial a failure rate of greater than 5% is found the iBMS system supplier is responsible for certifying all points related to the application use case for proper functionality and performance.
4. The Contractor shall submit a written report documenting successful completion of functional demonstrating testing including all assumptions, conditions, allowances and corrections made during the test.

### 3.5 TRAINING

- A. O&M Training: Onsite training specific to the equipment furnished shall be provided to the Owner's staff by a factory trained manufacturer's representative. Training duration shall be sufficiently adequate to cover the operation and maintenance of the equipment and shall consist of not less than 1 session(s) with 24 hours of onsite classroom and hands-on instruction for a minimum of 4 attendees per session.
  - 1. The instructor shall provide sufficient time and detail in each session to cover the following as a minimum:
    - a. Theory of operation
    - b. Major components of equipment
    - c. Operation of equipment
    - d. Configurations of equipment
    - e. Maintenance, troubleshooting and repair
    - f. Replacement of component level parts
  - 2. The submitted O&M manuals shall be used for training

END OF SECTION 250010

## SECTION 260100

### BASIC ELECTRICAL REQUIREMENTS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specifications, apply to this and the other sections of these specifications.

##### 1.02 SUMMARY

- A. This Section includes general administrative and procedural requirements, as well as the project general requirements for the job.

##### 1.03 PROJECT GENERAL REQUIREMENTS

- A. The intent of the drawings and specifications is to provide complete and properly functioning building systems. The Contractor shall provide all labor and material necessary to achieve such ends.
- B. The plans and specifications are to be considered complimentary. Contractor shall refer to specifications of other trades. In case of discrepancies, the most stringent shall apply, as determined by the Engineer.
- C. Consider the riser diagrams and details as part of the Contract Documents. Provide equipment conduit, wire and other accessories shown on riser diagrams and details as if they were shown on the floor plans.
- D. Provide minor items, accessories or devices as necessary for completion and proper operation of systems, whether or not they are specifically indicated by specifications or drawings.
- E. Work that is installed in a method not in accordance with the contract documents, as determined by the Engineer, shall be removed at no additional cost or time penalty to the Owner.
- F. The Contractor shall thoroughly examine the contract drawings, visit the site and verify, in the field, all existing conditions before submitting a bid. By the submission of a bid, the Contractor shall acknowledge acceptance of this plan set as an adequate definition of the scope of work and extra cost claims based on inadequacy of plans shall not be considered. No consideration or allowance shall be granted for failure to investigate existing conditions or misunderstandings of the contractual requirements.
- G. Definitions: Refer to the drawings and other sections of these specifications for definitions not included below:
  - 1. "Contract Documents": Complete project specifications and drawings.

2. "Provide": Furnish and install.
  3. "Furnish": Supply and deliver to the project site.
  4. "Install": Erect in place.
  5. "Concealed": Hidden by walls and/or ceilings.
  6. "Exposed": Visible to view.
  7. "Indicated": Shown in the contract documents.
- H. The Contractor shall provide all equipment and materials in accordance with the best engineering practice. Follow the manufacturer's published installation instructions and provide all required auxiliary items. Show all required items on layout drawings.
- I. All equipment provided shall be new and the current models for which technical support from the manufacturer and replacement parts are available.
- J. All equipment supplied shall be suitable for the purpose intended. All manufacturers shall have had similar products in service for a minimum of three (3) years.
- K. Coordinate work and equipment of all sections within Division 26 with work and equipment of other divisions, to assure complete and satisfactory installation:
1. Perform work, such as: excavation, backfill, concrete, flashing and fire proofing required by Division 26 in compliance with requirements of other applicable divisions of the specifications.
- L. Field direction that is perceived as different or contradictory to the contract documents shall not relieve the Contractor from complying with the contract documents.
- M. Where site conditions require minor deviations from the contract documents, make such deviations without cost to the owner. Major deviations shall not be made without obtaining written permission from the owner.
- N. The Contractor shall remove designated existing equipment to a location at the project site determined by the owner. After the equipment has been gathered for owner inspection and possible retention, all equipment not retained by the owner shall be removed from the site by the Contractor.
- O. The Contractor shall verify proper operation of all existing items and equipment indicated to be reused. The Contractor shall report any deficiencies in the existing equipment/materials to the owner.
- P. Thoroughly clean all items and equipment indicated to be reused.
- Q. The Contractor shall provide temporary lighting and power as necessary for demolition and construction phases of work. All temporary work shall be in accordance with OSHA requirements. Temporary power shall be 120V, unless required otherwise.

- R. The Contractor shall notify the Construction Manager when the project is 75% complete to schedule a pre-final review of construction. No work shall be concealed by ceilings, walls, etc. prior to the pre-final review of construction. Final review shall be scheduled at 100% completion. The Contractor shall complete all punch list items before submitting for final acceptance.
- S. The Contractor shall thoroughly clean the contract area daily. Upon completion of the work, the Contractor shall thoroughly clean the contract area and all other areas used for storage, staging, etc.
- T. All work shall be installed in accordance with building construction rules and regulations. Contractor shall obtain and review same prior to submitting a bid.

#### 1.04 CONTRACT DRAWINGS

- A. Drawings indicate arrangements, approximate sizes and relative locations of major apparatus, equipment, devices and services provided as part of the Work.
  - 1. Check and compare layout of equipment indicated on drawings against all drawings, specifications of all divisions, and exact locations determined using approved shop drawings of such equipment.
  - 2. Where physical interference occurs, consult with the Engineer and prepare dated, dimensioned drawings correcting such interferences. Submit to the Engineer for review of such drawings.
    - a. Do not scale drawing to determine working dimension. Such measurements shall be taken from figured dimensions.
    - b. Verify all dimensions with the Architect and Construction Manager.

#### 1.05 DELIVERY, STORAGE AND HANDLING

- A. Refer to other divisions of this specification for location of Contractor storage and staging area.
- B. Deliver all materials with factory-applied end closures. Maintain end closures through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- C. Protect materials from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- D. Protect all electrical equipment from moisture and dirt.
- E. Provide temporary heating for equipment to minimize the possibility of condensation.

#### 1.06 SEQUENCING AND SCHEDULING

- A. Coordinate electrical equipment installation other building components.



- B. Arrange for chases, slots, sleeves 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 electrical 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 mechanical services where these services are necessary for the safe and proper operation of the electrical equipment being installed.
- F. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, controlling agencies and the owner's physical plant operators.
- G. Coordinate requirements for access panels and doors where electrical items requiring access are concealed behind finished surfaces.
- 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.

#### 1.07 PRE-BID 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 that 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.

#### 1.08 OUTAGES

- A. For all work requiring an outage, the Contractor shall submit an outage request to the Owner and Construction Manager in enough time to allow a 3-week review or as required by Division 01. The outage request shall include as a minimum:
  - 1. System(s) effected.
  - 2. Proposed isolation points.
  - 3. Start and duration of outage.
  - 4. Contractor contact person.
  - 5. Emergency procedures.
  - 6. Method of procedure.
- B. 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 Owner.

- C. 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 or of other building on the campus
- D. The operation of electrical equipment required to achieve an outage must be accomplished by the Owners personnel only. Prospective Sub-contractors under this section are cautioned that the unauthorized operation of power switches, or other control devices by their personnel can result in extremely serious consequences for which the Contractor will be held accountable.

#### 1.09 CUTTING, WELDING, BURNING

- A. Before the Contractor commences any cutting, and welding the Contractor shall obtain a hot work permit from the Owner.
- B. The hot work permit copy shall remain on the job site at the hot work location until such work is completed.

#### 1.10 PERFORMANCE REQUIREMENTS

- A. Contract drawings are generally diagrammatic and do not indicate all offsets, fittings, transitions, access panels and other specialties required.
- B. Furnish and install all items as may be required to fit the work to the conditions encountered.
- C. Arrange conduit, raceways, junction boxes or circuitry and other work generally as shown on the contract drawings, providing proper clearances and access.
- D. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawing submittal for approval in accordance with Submittals specified below.
- E. The Owner may make reasonable changes in location of equipment, conduit, raceways, junction boxes or circuitry up to the time of rough-in or fabrication at no charge and with no time extension.
- F. Equipment submitted that is not basis of design must meet all specified/scheduled performance criteria. No additional compensation will be made to the Contractor if substituted equipment does not meet performance criteria.

#### 1.11 MATERIALS AND EQUIPMENT

- A. The contract drawings and system performances have been designed on the basis of using the particular manufacturer's products specified or scheduled on the contract drawings.
- B. All proposed substitutions shall be reviewed by the Design Engineer. The determination of equal products to the prototype shall be at the sole discretion of the Design Engineer.

- C. Products of other manufacturers listed in the specification shall be permitted provided as follows:
1. Product shall meet the specifications.
  2. Any substitutions for the approved product will require the contractor to make all required changes to all associated trades to accommodate the substitution at no cost or time impact to the project. All substitutions shall be provided with a credit. Substitutions submitted for review without a credit will be returned "Rejected/Resubmit".
  3. All changes shall be made, without additional cost to the Owner or effort by the design team. The Contractor shall be responsible to provide all adjustments for deviations, such that the final installation is complete and functions as the basis of design product is intended. For equipment substitutions, the Contractor shall make all required accommodations to utilize unit selected, at no additional cost to Owner including but not limited to:
    - a. Electrical modifications including circuit breaker fuse, disconnect switch, conduit and wire size.
    - b. Structural modifications.
    - c. Providing National Electrical Code (NEC) and Authority Having Jurisdiction (AHJ) required service clearances.
    - d. Space requirements with all other trades if physical dimensions are different than shown in the construction documents.
- D. Products with dimensions or other characteristics different from the basis of design product that render their use impractical or cause functional fit, access, or connection problems, shall not be acceptable.

#### 1.12 SUBMITTALS

- A. General: Follow the procedures specified in Division 01 "Submittals," except as modified below.
- B. The purpose of the submittal process is to show, via products, shop drawings, performance data, and calculations, how the Contractor will conform to the contract documents.
- C. Shop drawing review by the Engineer is only for the limited purpose of checking for conformance with the information given in the construction documents. Review is not conducted for the purpose of determining the accuracy of or completeness such as dimensions or quantities.
- D. The Contractor shall submit shop drawings, coordination drawings, fabrication drawings and receive approval prior to construction or ordering of same.
- E. Approval by Engineer does not absolve Contractor of code or Authority Having Jurisdiction (AHJ) requirements.

- F. Submittals must clearly indicate the specific products, accessories and where they will be used on this project. Submittals that do not contain the above information will be rejected.
- G. Submittals shall be reviewed by the Contractor and bear his stamp that the submittal meets the contract documents. Submittals that are not stamped shall be rejected as they will not have proof that the Contractors have adequately reviewed the submittal for compliance with the contract documents.
- H. Submittals shall be reviewed not more than two (2) times. If the Contractor fails to submit shop drawings that are approved by the Design Engineer within two attempts, he will be back charged at the current contract rate for the engineer for subsequent reviews.
- I. The design engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- J. Submit samples of color, lettering style, and other graphic representation required for each identification material and device.
- K. Shop drawings detailing fabrication and installation for all supports and anchorage for electrical materials and equipment shall be provided with the specific piece of equipment.
- L. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.
- M. All resubmittals must come with narrative on the Contractor's company letterhead responding to the Engineer's review comments and describing changes made.

#### 1.13 SUBSTITUTIONS

- A. 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.
- B. Identify the product or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers.
- C. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
  - 1. Coordination information, including a list of changes or modifications needed to other parts of the work and to construction performed by the tenant and separate contractors, which will be necessary to accommodate the proposed substitution.
  - 2. A detailed comparison of significant qualities of proposed substitutions with those of the work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the work specified.

3. Product Data, including Drawings and descriptions of products and fabrication and installation procedures.
4. Samples, where applicable or requested.
5. Certificates and qualification data, where applicable or requested.
6. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
7. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
8. Research reports evidencing compliance with building code in effect for project.
9. Detailed comparison of contractor's construction schedule using proposed substitution with products specified for the work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided with the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
10. Cost information, including a proposal of the net change, if any in the Contract Sum.
11. 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.
12. 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.
13. Confirmation that the same warranty will be furnished for substitute product as for specified product.

#### 1.14 COORDINATION DRAWINGS

- A. Prepare coordination drawings in accordance with Division 01 to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Coordination drawing shall include the specific equipment proposed by the Contractor and not just generic or prototype equipment. 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 conduit, raceways, junction boxes, circuitry equipment, and materials. Include the following:
    - a. All sizes, shapes, connection points, service clearances, weights, support points of each proposed piece of equipment and the structure, adjacent equipment.
    - b. Clearances for installing and maintaining systems and components.
    - c. Clearances for servicing and maintaining equipment, including space for equipment disassembly if required for periodic maintenance.
    - d. Equipment connections and support details.
    - e. Exterior wall and foundation penetrations.
    - f. Fire-rated wall and floor penetrations.
    - g. Sizes and location of required concrete pads and bases.
    - h. Access door location and size.

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 wall or ceiling mounted access doors for electrical devices.
4. In conjunction with other trades, prepare coordinated reflected ceiling and floor plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, cable trays, sprinklers, access doors, fire alarm devices, security devices, equipment locations (with indicated clearances) and other pertinent items.
5. Provide information only drawing for the work that will be solely for the benefit of the Contractor and not for design engineer review including:
  - a. Sleeve drawings.
  - b. Low voltage hangers.

#### 1.15 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Division 01. In addition to the requirements specified in Division 01, indicate the following installed conditions:
  1. Switchgear/switchboard/panelboard layout.
  2. As-built single-line drawing indicating all conduit and conductor sizes, all over-current protection device (circuit breaker/fused switch) rating, settings sizes and type.
  3. As-built feeder sizes and routing.
  4. Complete switchgear/switchboard and panel schedules, as installed and calibrated.
  5. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
  6. Maintenance clearances and access points.
  7. Numbering coordinated with contract documents and O&M manuals.
  8. Approved substitutions, Contract Modifications, Responses to Contractor's Request for Information, and actual equipment and materials installed.
- B. Engage the services of a Land Surveyor or Professional Engineer registered in the state in which the project is located to record the locations and invert elevations of underground installations.

#### 1.16 OPERATION AND MAINTENANCE MANUALS

- A. Prepare operations and maintenance manuals in accordance with Division 01 Section "Project Closeout." In addition to the requirements specified in Division 01, include the following information for equipment items:
  1. Periodic maintenance schedule.
  2. Parts list.
  3. Parts supplier listing.
  4. Service diagrams.
- B. The Contractor shall provide three (3) bound copies of manufacturer's published operating and maintenance instructions for all serviceable equipment provided under this contract. Operating

and maintenance instructions shall be presented to the design engineer bound in three ring binders and as electronic PDF on a flash drive and tabbed by system, before the pre-final review of construction.

1. List of systems and equipment requiring service manuals.
2. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
3. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
4. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
5. Servicing instructions and lubrication charts and schedules.
6. Systems and equipment test reports.
7. All warranties for equipment installed on this project.
8. Contractor's workmanship and materials warranty.
9. Start-up report in readable legible fashion.
10. Copy of final test and inspection reports and copy of final approval.

#### 1.17 UNDERWRITER'S LABORATORY (UL) REQUIREMENTS

- A. All equipment shall bear the Underwriter's Laboratory (UL) label, as a complete packaged system.
  1. Equipment not provided with a UL label shall be tested in the field, certified and provided with a UL label at the installer's expense.
  2. Field testing shall be performed by a testing agency approved by the authority having jurisdiction.

#### 1.18 FIRE SAFE MATERIALS

- A. Unless otherwise indicated, materials shall conform to UL, NFPA or ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of twenty-five (25) and smoke developed of fifty (50).

#### 1.19 COLOR SELECTION

- A. Color of finishes shall be as selected by the Architect. Submit colors of factory finished equipment for acceptance prior to ordering.

#### 1.20 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 Design Engineer shall decide on the item and manner in which the work shall be provided.

## 1.21 GUARANTEE/WARRANTY

- A. All materials, equipment, etc. provided by the Contractor shall be guaranteed and warranted to be free from defects in workmanship and materials for a period of two (2) years after date of substantial completion and acceptance of work by the Owner or as required by Division 01. 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. In default thereof, Owner may have such work done and charge the cost of same to the Contractor. Any special warranties shall be as detailed in relevant specification sections. Manufacturer's standard warranties shall not absolve Contractor of specification requirements.

## PART 2 - PRODUCTS

### 2.01 CONCRETE AND MASONRY WORK

- A. Concrete: 3,500 psi compressive strength after twenty-eight (28) days.

### 2.02 GROUT

- A. Non-shrink, Nonmetallic Grout: ASTM C 1107, Grade B.
1. Characteristics: Post hardening, volume adjusting, dry, hydraulic cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  2. Design Mix: 5000-psi (34.50MPa), twenty-eight (28) day compressive strength
  3. Packaging: Premixed and factory-packaged

### 2.03 ACCESS DOORS AND PANELS

- A. Provide manufactured steel door assemblies consisting of:
1. Hinged door.
  2. Flush screwdriver cam locks and frame.
- B. Unless otherwise noted on the architectural drawing and specifications, access doors shall be Milcor Metal Access doors or approved equal. Provide key locks where indicated.
- C. Design shall be provided for the following installations:
1. Acoustical or Cement Plaster: Style B.
  2. Hard Finish Plaster: Style K or L.
  3. Masonry or Dry Wall: Style M.

## PART 3 - EXECUTION

### 3.01 ROUGH-IN



- A. Verify final locations and characteristics for electrical rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications included in the electrical specifications for additional equipment rough in requirements.

### 3.02 ELECTRICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of the electrical systems, materials, and equipment. Comply with the following requirements:
  - 1. Coordinate with all other trades, construction contractors and equipment providers to avoid interference among electrical, mechanical, plumbing, fire protection, fire alarm, security, information technology, audio visual, controls, structural and architectural items. Provide all necessary offsets and fittings in conduit, raceways, cable trays, circuitry and other items required to install the work without interferences.
  - 2. Coordinate electrical systems, equipment, and materials installation with other building components.
  - 3. Verify all dimensions by field measurements.
  - 4. Arrange for chases, slots, sleeves and openings in other building components during progress of construction, to allow for electrical installations.
  - 5. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
  - 6. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
  - 7. Where systems, materials and equipment are intended for overhead installation, and where mounting heights are not detailed or dimensioned, install systems, materials, and equipment as high as possible to provide the maximum headroom possible. Notify the Owner prior to installation when headroom is less than 7'-6".
  - 8. The Contractor shall install all conduit, raceways, junction boxes, circuitry, etc., as high as possible. All conduit, raceways, junction boxes, circuitry, etc., shall, unless otherwise noted, be run parallel to or perpendicular to building walls or structural grid in a neat workmanlike manner, unless specifically noted. Provide all support steel, hangers, vibration isolation and accessories necessary for equipment per manufacturer's recommendations. Do not support any ceilings or other building structure from conduit, raceways, junction boxes or circuitry. Do not allow conduit, raceways, junction boxes or circuitry to come into direct contact with building walls or floors. Do not support conduit, raceways, junction boxes or circuitry from installed ductwork, other piping, raceways, circuitry, etc. Each installed utility shall be individually supported from the building structure.
  - 9. Where access panels are required for equipment service access, the Contractor shall coordinate final access panel location with equipment location. The Contractor shall furnish and install access panels of sufficient sizes to allow for NEC mandated clearances and for service as indicated in the manufacturer's published operation and maintenance manuals.

10. Provide openings in building construction for passage of conduit, raceways or circuitry. Repair all walls, ceilings and floors, penetrated. Repairs shall be with materials and finishes that match existing construction and as indicated in the Architectural portions of these specifications. Submit floor slab penetration drawings and details as Information Submittals for record only. Do not penetrate structural members without prior approval from the structural engineer.
11. The Contractor shall carefully coordinate the openings in the electrical and mechanical rooms to allow the rigging of the equipment. The major electrical equipment such as switchgear and transformers shall be shipped to the site in sections, wherever appropriate, so that the equipment will fit in the openings provided.
12. 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. Provide required connection for each service.
13. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Construction Manager.
14. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.
15. 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.
16. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

### 3.03 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with Architectural Specification. In addition to the requirements specified in the Division 01, 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. Remove samples of installed Work as specified for testing.
  5. Install equipment and materials in existing structures.
  6. Commission the work.
- C. Upon written instructions from the Construction Manager, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

- D. Cut, remove and legally dispose of selected electrical equipment, components, and materials as indicated.
- E. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- F. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
  - 1. Patch finished surfaces and building components using new materials specified for the original installation and using experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.
    - a. Refer to Division 01.

### 3.04 PAINTING AND FINISHING

- A. Refer to Architectural Specification Section "Painting" for field painting requirement.
- B. Damage and Touch Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- C. Do not paint manufacturer's labels or tags.

### 3.05 CONCRETE BASES

- A. Construct concrete equipment bases not less than four (4) inches larger than supported unit in both directions. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000-psi, twenty-eight (28) day compressive strength concrete and reinforcement bars as specified in the architectural specifications. Housekeeping pads shall be 4-inches in height.

### 3.06 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS D1.1 "Structural Welding Code--Steel"

### 3.07 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor electrical materials and equipment.
- B. Select fastener sizes that will not 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 members.

- C. Attach to substrates as required to support applied loads.

### 3.08 DEMOLITION

- A. Disconnect, demolish, and remove work specified as part of the electrical specifications and as indicated. Remove conduits, raceways, feeders and branch circuits back to the active source.
- B. Where conduits, raceways, feeders, branch circuits or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
- C. Accessible Work: Remove indicated exposed conduits, raceways, feeders, branch circuits or equipment in its entirety.
- D. Abandoned Work: Cut and remove buried conduit abandoned in place, two (2) inches (50 mm) beyond the face of adjacent construction. Cap and patch surface to match existing finish.
- E. Removal: Remove demolished equipment from the Project site.
- F. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

### 3.09 GROUTING

- A. Install nonmetallic non-shrink grout for electrical equipment base plates, and anchors. Mix grout according to manufacturer's printed instructions.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms for placement of grout, as required.
- D. Avoid air entrapment when placing grout.
- E. Place grout to completely fill equipment bases.
- F. Place grout on concrete bases to provide a smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout according to manufacturer's printed instructions.

### 3.10 PENETRATION OF WATERPROOF CONSTRUCTION

- A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, foundation walls and interior waterproof construction.
- B. Install waterproof sealing systems in accordance with the manufacturer's instructions.

### 3.11 EXCAVATION AND BACKFILLING

#### A. General:

1. Perform all necessary excavation, for installation of work as part of the electrical specifications in accordance with the Division 01.

### 3.12 CLEANING AND FINISHES

- A. Clean surfaces prior to application of insulation, adhesives, coating, and paint.
- B. Provide factory applied finish where specified.
- C. Protect all finishes, and restore all finishes to their original condition if damaged as a result of work installed as part of the electrical specifications.
- D. Remove all construction marking and writing from exposed equipment, conduits and building surfaces.

### 3.13 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 in conduits and equipment to prevent the entrance of water, dirt, debris, and other foreign matter.

### 3.14 PROVISIONS FOR ACCESS

- A. Furnish and install adequate access to all electrical equipment and components. The following list shall be used as a guide only:
  1. Equipment.
  2. Switches.
  3. Terminal blocks.
  4. Panelboards.
  5. Controls.
- B. Access shall be adequate as determined by the Engineer.
- C. Refer to contract drawings where access panels have been specifically located.
- D. Provide additional access panels for adequate access as indicated in paragraph 'A' above.

- E. Where access is by means of lift out ceiling tiles or panels mark each access panel, using small color coded or numbered tabs. Provide an index chart for identification. Place markers in corner of tile.

### 3.15 OPERATION OF EQUIPMENT DURING CONSTRUCTION

- A. Clean all systems and equipment prior to initial operation for testing and balancing.
- B. Do not operate equipment unless all proper safety devices or controls are operational.
- C. Provide all maintenance and service for equipment which is operated during construction.
- D. Provide the services of a manufacturer's factory trained service organization to start the equipment. Submit testing report prior to equipment demonstration.
- E. Upon completion of work, clean and restore all equipment to new conditions

### 3.16 SPARE PARTS

- A. Spare Attic Stock shall be EXCLUDED from bid pricing. Contractor shall review required spare parts & attic stock with Owner prior to project turnover.

### 3.17 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. Correct any difficulties prior to requesting 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. Contractor shall pre-test all equipment prior to requesting demonstration and instruction.
- C. Use operation and maintenance manuals and videos as basis of instruction. Review contents of manual and video with personnel in detail to explain all aspects of operation and maintenance. Provide a sign-in sheet for each training session.
- D. Demonstrate the following:
  - 1. Start up.
  - 2. Operation.
  - 3. Control.
  - 4. Adjustment.
  - 5. Troubleshooting.
  - 6. Servicing.

7. Maintenance.
8. Shutdown.

### 3.18 WALL AND FLOOR PENETRATION

- A. All penetrations of partitions, walls and floors by conduits or raceways shall be sealed and caulked. Provide U.L. listed fire stopping systems at penetrations through fire walls as specified in the architectural specifications.

### 3.19 AS BUILT DRAWINGS

- A. Upon completion of the electrical installations, the Installer shall deliver to the Construction Manager two (2) complete sets of marked-up blueprints and one electronic PDF file of as-built conditions.
  1. All mark-ups shall be made on the Contract Document set of drawings.
  2. 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.
  3. Refer to General Requirements of Architectural Specification Section for additional requirements pertaining to Submittals and Record Drawings.
- B. The contractor shall provide a LOD 500 Revit 2017 model with complete systems layout based on the exact equipment approved and installed.

### 3.20 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. Operation.
3. Shut down.
4. Emergency operations.
5. Noise and vibration adjustments.
6. Safety procedures.
7. Economy and efficiency adjustments.
8. Effective energy utilization.

C. Submit all documentation and obtain approval as required for LEED certification.

### 3.21 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 clipping, wiring, nuts, bolts, etc. left on top of ceilings and ceiling tiles.

### 3.22 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 260519

### LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes: Copper building wire rated 600 V or less; Metal-clad cable, Type MC, rated 600 V or less and Connectors, splices, and terminations rated 600 V and less.

##### 1.03 DEFINITIONS

- A. RoHS: Restriction of Hazardous Substances.
- B. VFC: Variable-frequency controller.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
  - 1. Lead content.
  - 2. Recycled content.
  - 3. Solvents and adhesives.
- C. Product Schedule: Indicate type, use, location, and termination locations.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.

##### 1.06 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

#### PART 2 - PRODUCTS

##### 2.01 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Alpha Wire Company.
  - 2. Cerro Wire LLC.
  - 3. Southwire Company.
- C. Standards:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  - 2. RoHS compliant.
  - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- E. Conductor Insulation:
  - 1. Type RHH and Type RHW-2: Comply with UL 44.
  - 2. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
  - 3. Type THHN and Type THWN-2: Comply with UL 83.
  - 4. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
  - 5. Type XHHW-2: Comply with UL 44.
- F. Shield:
  - 6. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, dual spirally wrapped copper tape shields and three bare symmetrically applied ground wires, and sunlight- and oil-resistant outer PVC jacket.

## 2.02 METAL-CLAD CABLE, TYPE MC

- A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
- B. 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. AFC Cable Systems; a part of Atkore International.
  - 2. General Cable Technologies Corporation.
  - 3. Southwire Company.
- C. Standards:
  - 4. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  - 5. Comply with UL 1569.
  - 6. RoHS compliant.
  - 7. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Circuits:
  - 1. Single circuit and multi-circuit with color-coded conductors.

- E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- F. Ground Conductor: Insulated.
- G. Conductor Insulation:
  - 1. Type TFN/THHN/THWN-2: Comply with UL 83.
- H. Armor: Aluminum, interlocked.

## 2.03 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. 3M Electrical Products.
  - 2. Hubbell Power Systems, Inc.
  - 3. Ideal Industries, Inc.
- C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
  - 1. Material: Compatible with conductor type, Copper.
  - 2. Type: Two hole with long barrels.
  - 3. Termination: Compression.

## PART 3 - EXECUTION

### 3.01 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.
- D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

### 3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.

- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.
- D. Exposed Branch Circuits: Type THHN/THWN-2, single conductors in raceway.
- E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway. All homeruns to the panelboard and branch circuits between rooms and areas served shall be single conductors in raceway. Metal-clad cable, Type MC is permitted for short runs to serve lighting and wiring devices within a single room or common area.
- F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.
- G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- H. VFC Output Circuits: Type TC-ER cable with dual tape shield.

### 3.03 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. 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.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

### 3.04 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, 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.

### 3.05 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

### 3.06 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### 3.07 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

### 3.08 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:
  - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
  - 2. After installing conductors and cables and before electrical circuitry has been energized, test feeder conductors.
  - 3. Perform each of the following visual and electrical tests:
    - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
    - b. Test bolted connections for high resistance using one of the following:
      - 1) A low-resistance ohmmeter.
      - 2) Calibrated torque wrench.
      - 3) Thermographic survey.
    - c. Inspect compression-applied connectors for correct cable match and indentation.
    - d. Inspect for correct identification.
    - e. Inspect cable jacket and condition.
    - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
    - g. Continuity test on each conductor and cable.
    - h. Uniform resistance of parallel conductors.
  - 4. Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

- i. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - j. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- D. Cables will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports to record the following:
  - 1. Procedures used.
  - 2. Results that comply with requirements.
  - 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION

## SECTION 260526

### GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section includes grounding and bonding systems and equipment.

##### 1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Sustainable Design Submittals:
  - 1. Lead content.

##### 1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency and testing agency's field supervisor.
- B. Field quality-control reports.

##### 1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
  - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - a. Plans showing as-built, dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
      - 1) Grounding arrangements and connections for separately derived systems.
    - b. Instructions for periodic testing and inspection of grounding features at test well, ground rings and grounding connections for separately derived systems based on NFPA 70B.
      - 1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
      - 2) Include recommended testing intervals.

##### 1.06 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Certified by NETA.

## PART 2 - PRODUCTS

### 2.01 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

### 2.02 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Burndy; Part of Hubbell Electrical Systems.
  - 2. O-Z/Gedney; a brand of Emerson Industrial Automation.
  - 3. Thomas & Betts, A Member of the ABB Group.

### 2.03 CONDUCTORS

- A. Insulated Conductors: **Copper** wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
  - 1. Solid Conductors: ASTM B 3.
  - 2. Stranded Conductors: ASTM B 8.
  - 3. Tinned Conductors: ASTM B 33.
  - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
  - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
  - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
  - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

### 2.04 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. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.



- D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- G. Conduit Hubs: Mechanical type, terminal with threaded hub.
- H. Straps: Solid copper, Rated for 600 A.
- I. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

## 2.05 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet
- B. Ground Plates: 1/4 inch thick, hot-dip galvanized.

## PART 3 - EXECUTION

### 3.01 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Grounding Bus in low voltage electrical service equipment rooms:
  - 1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor 24" long unless otherwise indicated.
- C. Grounding Bus in rooms housing electrical distribution equipment, such as panelboards and transformers:
  - 1. Install 24" section of bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor, unless indicated otherwise.
- D. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Connections to Structural Steel: Welded connectors.

### 3.02 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

### 3.03 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

### 3.04 INSTALLATION

- A. 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. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- D. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
  - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
  - 2. Make connections with clean, bare metal at points of contact.
  - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  - 4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
  - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

### 3.05 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.
- D. Tests and Inspections:
  - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal. Coordinate subparagraph below with "Informational Submittals" Article; revise to suit Project.
- E. Grounding system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.
- G. Report measured ground resistances that exceed the following values:
  1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
  2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
  3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
  4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
- H. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

## SECTION 260529

### HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Steel slotted support systems.
  - 2. Conduit and cable support devices.
  - 3. Support for conductors in vertical conduit.
  - 4. Structural steel for fabricated supports and restraints.
  - 5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
  - 6. Fabricated metal equipment support assemblies.

##### 1.03 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 the following:
    - a. Slotted support systems, hardware, and accessories.
    - b. Clamps.
    - c. Hangers.
    - d. Sockets.
    - e. Eye nuts.
    - f. Fasteners.
    - g. Anchors.
    - h. Saddles.
    - i. Brackets.
  - 2. Include rated capacities and furnished specialties and accessories.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for electrical hangers and support systems.
  - 1. Hangers. Include product data for components.
  - 2. Slotted support systems.
  - 3. Equipment supports.
  - 4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal: For hangers and supports for electrical systems.
  - 1. Include design calculations and details of hangers.

#### 1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Suspended ceiling components.
  - 2. Ductwork, piping, fittings, and supports.
  - 3. Structural members to which hangers and supports will be attached.
  - 4. Size and location of initial access modules for acoustical tile.
  - 5. Items penetrating finished ceiling, including the following:
    - a. Luminaires.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
    - e. Access panels.
    - f. Projectors.
    - g. Fire alarm devices
- B. Welding certificates.

#### 1.05 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M.
  - 2. AWS D1.2/D1.2M.

### PART 2 - PRODUCTS

#### 2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 4000 "Quality Requirements," to design hanger and support system.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame Rating: Class 1.
  - 2. Self-extinguishing according to ASTM D 635.

#### 2.02 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
  - 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. B-line, an Eaton business.
    - b. ERICO International Corporation.
    - c. Unistrut; Part of Atkore International.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
  3. Material for Channel, Fittings, and Accessories: Galvanized steel
  4. Channel Width: Selected for applicable load criteria
  5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
  7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete, 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) B-line, an Eaton business.
      - 2) Hilti, Inc.
      - 3) ITW Ramset/Red Head; Illinois Tool Works, Inc.
  2. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
  3. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
  4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
  5. Toggle Bolts: Stainless-steel springhead type.
  6. Hanger Rods: Threaded steel.

## 2.03 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 05 5000 "Metal Fabrications" for steel shapes and plates.

## PART 3 - EXECUTION

### 3.01 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
  - 1. NECA 1.
  - 2. NECA 101
  - 3. NECA 102.
  - 4. NECA 105.
  - 5. NECA 111.
- B. Comply with requirements in Division 07 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways and boxes specified in Section 26 0533 "Raceways and Boxes for Electrical Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.

### 3.02 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, according to NFPA 70.
- C. 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.
- D. 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. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
  6. To Light Steel: Sheet metal screws.
  7. 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.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

### 3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 05 5000 "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.

### 3.04 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.
- C. Anchor equipment to concrete base as follows:
  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.

### 3.05 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

### RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Metal conduits and fittings.
  - 2. Surface raceways.
  - 3. Boxes, enclosures, and cabinets.

##### 1.03 DEFINITIONS

- A. GRC: Galvanized rigid steel conduit.
- B. EMT: Electrical Metallic Tubing

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For surface raceways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Sustainable Design Submittals:
  - 1. Product Data: For solvents and adhesives, indicating VOC content.
- C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.
- D. Samples: For surface raceways and for each color and texture specified, 12 inches long.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
  - 1. Structural members in paths of conduit groups with common supports.
  - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- B. Qualification Data: For professional engineer.
- C. Source quality-control reports.

## PART 2 - PRODUCTS

### 2.01 METAL CONDUITS AND FITTINGS

#### A. Metal Conduit:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Allied Tube & Conduit; a part of Atkore International.
  - b. Anamet Electrical, Inc.
  - c. Electri-Flex Company.
  - d. O-Z/Gedney; a brand of Emerson Industrial Automation.
  - e. Thomas & Betts Corporation; A Member of the ABB Group.
  - f. Western Tube and Conduit Corporation.
  - g. Wheatland Tube Company.
2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. GRC: Comply with ANSI C80.1 and UL 6.
4. EMT: Comply with ANSI C80.3 and UL 797.
5. FMC: Comply with UL 1; zinc-coated steel.
6. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

#### B. Metal Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Allied Tube & Conduit; a part of Atkore International.
  - b. Anamet Electrical, Inc.
  - c. Electri-Flex Company.
  - d. O-Z/Gedney; a brand of Emerson Industrial Automation.
  - e. Picoma Industries, Inc.
  - f. Thomas & Betts Corporation; A Member of the ABB Group.
  - g. Western Tube and Conduit Corporation.
  - h. Wheatland Tube Company.
2. Comply with NEMA FB 1 and UL 514B.
3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Fittings, General: Listed and labeled for type of conduit, location, and use.
5. Fittings for EMT:
  - a. Material: Steel.
  - b. Type: Compression.
6. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

7. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- C. Joint Compound GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## 2.02 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
  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. Legrand US.

## 2.03 BOXES, ENCLOSURES, AND CABINETS

- 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. EGS/Appleton Electric.
  2. Hoffman; a brand of Pentair Equipment Protection.
  3. Hubbell Incorporated.
  4. O-Z/Gedney; a brand of Emerson Industrial Automation.
  5. RACO; Hubbell.
  6. Spring City Electrical Manufacturing Company.
  7. Thomas & Betts Corporation; A Member of the ABB Group.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- G. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

- H. Gangable boxes are prohibited.
- I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 and Type 4 with continuous-hinge cover with flush latch unless otherwise indicated.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- J. 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

#### 3.01 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
  - 1. Exposed Conduit: GRC.
  - 2. Concealed Conduit, Aboveground: GRC.
  - 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 4.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
  - 1. Exposed, Not Subject to Physical Damage: EMT.
  - 2. Exposed and Subject to Physical Damage: GRC. Raceway locations include the following, up to 10 feet above finished floor:
    - a. Loading dock.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical and Electrical rooms.
  - 3. Concealed in Ceilings and Interior Walls and Partitions: EMT
  - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
  - 5. Damp or Wet Locations: GRC.
  - 6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in damp or wet locations.
- C. Minimum Raceway Size: 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. Comply with NEMA FB 2.10.
  - 2. EMT: Use set-screw, steel fittings. Comply with NEMA FB 2.10.
  - 3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install surface raceways only where indicated on Drawings.

### 3.02 INSTALLATION

- A. Comply with requirements in Section 26 0529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Do not install raceways or electrical items on any rotating equipment.
- D. Do not fasten conduits onto the bottom side of a metal deck roof.
- E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- F. Complete raceway installation before starting conductor installation.
- G. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches of enclosures to which attached.
- L. Stub-Ups to Above Recessed Ceilings:
  - 1. Use EMT for raceways.
  - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- N. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- O. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat

metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

- Q. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- S. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- T. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- U. Surface Raceways:
  - 1. Install surface raceway with a minimum 2-inch radius control at bend points.
  - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- V. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- W. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
  - 1. Where an underground raceway enters a building or structure.
  - 2. Conduit extending from interior to exterior of building.
  - 3. Conduit extending into pressurized duct and equipment.
  - 4. Where otherwise required by NFPA 70.
- X. Expansion-Joint Fittings:
  - 1. Install in each run of aboveground GRC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
  - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F change.
    - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg temperature change.
  - 3. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
  - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- Y. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 36 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
  1. Use LFMC in damp or wet locations.
- Z. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- AA. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

### 3.03 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07 "Penetration Firestopping."

### 3.04 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
  1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

**END OF SECTION 260533**

## SECTION 260553

### IDENTIFICATION FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Color and legend requirements for raceways, conductors, and warning labels and signs.
  - 2. Labels.
  - 3. Tapes and stencils.
  - 4. Tags.
  - 5. Signs.
  - 6. Cable ties.
  - 7. Paint for identification.
  - 8. Fasteners for labels and signs.

##### 1.03 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 electrical identification products.
- B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.
- D. Delegated-Design Submittal: For arc-flash hazard study.

#### PART 2 - PRODUCTS

##### 2.01 PERFORMANCE REQUIREMENTS

- A. Comply with ASME 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. Comply with NFPA 70E for arc-flash warning labels.



- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change: 20 deg F, ambient; 180 deg F, material surfaces

## 2.02 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
  - 1. Black letters on an orange field
  - 2. Legend: Indicate voltage and system or service type.
- B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for conductors.
  - 1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
  - 2. Colors for 208/120-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Phase C: Blue.
  - 3. Colors for 480/277-V Circuits:
    - a. Phase A: Brown.
    - b. Phase B: Orange.
    - c. Phase C: Yellow.
  - 4. Color for Neutral: White or gray.
  - 5. Color for Equipment Grounds: Green or Green with a yellow stripe.
- C. Warning Label Colors:
  - 1. Identify system voltage with black letters on an orange background.
- D. Warning labels and signs 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."
- E. Equipment Identification Labels:
  - 1. Black letters on a white field.

## 2.03 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
  - 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. Brady Corporation.
    - b. Champion America.
    - c. Marking Services, Inc.

- d. Panduit Corp.
- e. Seton Identification Products.
- B. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
  - 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. Brady Corporation.
    - b. Ideal Industries, Inc.
    - c. Marking Services, Inc.
    - d. Panduit Corp.
    - e. Seton Identification Products.
  - 2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
  - 3. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- C. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
  - 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. Brady Corporation.
    - b. Ideal Industries, Inc.
    - c. Marking Services, Inc.
    - d. Panduit Corp.
    - e. Seton Identification Products.
  - 2. Minimum Nominal Size:
    - a. 1-1/2 by 6 inches for raceway and conductors.
    - b. As required by authorities having jurisdiction.

## 2.04 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
  - 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. Champion America.
    - b. Ideal Industries, Inc.
    - c. Marking Services, Inc.
    - d. Panduit Corp.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.
  - 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. Brady Corporation.

- b. Marking Services, Inc.
- C. Tape and Stencil: 4-inch-wide black stripes on 10-inch centers placed diagonally over orange background and are 12 inches wide. Stop stripes at legends.
  - 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. Marking Services, Inc.
    - b. Seton Identification Products.
- D. Floor Marking Tape: 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.
  - 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. Seton Identification Products.

## 2.05 TAGS

- A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use on medium voltage feeders with self-locking cable tie fastener.
  - 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. Brady Corporation.
    - b. Marking Services, Inc.
    - c. Seton Identification Products.

## 2.06 SIGNS

- A. Baked-Enamel Signs:
  - 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. Champion America.
    - b. Marking Services, Inc.
  - 2. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
  - 3. 1/4-inch grommets in corners for mounting.
  - 4. Nominal Size: 7 by 10 inches.
- B. Metal-Backed Butyrate Signs:
  - 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. Brady Corporation.
    - b. Champion America.
    - c. Marking Services, Inc.
  - 2. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.

3. 1/4-inch grommets in corners for mounting.
  4. Nominal Size: 10 by 14 inches.
- C. Laminated Acrylic or Melamine Plastic Signs:
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. Brady Corporation.
    - b. Marking Services, Inc.
  2. Engraved legend.
  3. Thickness:
    - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
    - b. For signs larger than 20 sq. in., 1/8 inch thick.
    - c. Engraved legend with black letters on white face.
    - d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
    - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

## 2.07 CABLE TIES

- 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. Ideal Industries, Inc.
  2. Marking Services, Inc.
  3. Panduit Corp.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
  3. Temperature Range: Minus 40 to plus 185 deg F.
  4. Color: Black.
- C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 Deg F according to ASTM D 638: 7000 psi.
  3. UL 94 Flame Rating: 94V-0.
  4. Temperature Range: Minus 50 to plus 284 deg F.
  5. Color: Black.

## 2.08 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain 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

### 3.01 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

### 3.02 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
  - 1. Secure tight to surface of conductor, cable, or raceway.
- H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- I. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer and load shedding.
- J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- K. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
  - 1. "EMERGENCY POWER."
  - 2. "POWER."
- L. Vinyl Wraparound Labels:
  - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.

2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- M. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.
- N. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- O. Self-Adhesive Labels:
  1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
  2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- P. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- Q. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
  1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- R. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- S. Metal Tags:
  1. Place in a location with high visibility and accessibility.
  2. Secure using UV-stabilized cable ties.
- T. Baked-Enamel Signs:
  1. Attach signs with mechanical fasteners appropriate to the location and substrate.
  2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.
- U. Metal-Backed Butyrate Signs:
  1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.
- V. Laminated Acrylic or Melamine Plastic Signs:
  1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.
- W. Cable Ties: General purpose, for attaching tags, except as listed below:
  1. Outdoors: UV-stabilized nylon.
  2. In Spaces Handling Environmental Air: Plenum rated.

### 3.03 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Accessible Raceways: Vinyl wraparound labels
  - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- D. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
  - 1. "EMERGENCY POWER."
  - 2. "POWER."
- E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive vinyl tape to identify the phase.
  - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- F. Conductors to Be Extended in the Future: Attach to conductors and list source.
- G. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
  - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- H. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- I. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-Metal-backed, butyrate warning signs.
  - 1. Apply to exterior of door, cover, or other access.
  - 2. 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.
- K. Arc Flash Warning Labeling: Self-adhesive labels.

- L. Operating Instruction Signs: Laminated acrylic or melamine plastic signs.
- M. Emergency Operating Instruction Signs: Laminated acrylic or melamine plastic signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer and load shedding.
- N. Equipment Identification Labels:
  - 1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
  - 2. Equipment to Be Labeled:
    - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a engraved, laminated acrylic or melamine label.
    - b. Enclosures and electrical cabinets.
    - c. Access doors and panels for concealed electrical items.
    - d. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
    - e. Emergency system boxes and enclosures.
    - f. Enclosed switches.
    - g. Enclosed circuit breakers.
    - h. Enclosed controllers.
    - i. Variable-speed controllers.
    - j. Push-button stations.
    - k. Contactors.
    - l. Monitoring and control equipment.
    - m. UPS equipment.

END OF SECTION 260553



## SECTION 260800 – ELECTRICAL SYSTEMS COMMISSIONING

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. The purpose of this section is to specify Division 26 responsibilities in the commissioning process which are being directed by the Commissioning Authority (CxA). Other electrical systems testing may be required under the direction of the General Contractor (GC).
- B. The commissioned equipment will consist of all controls systems in the project scope.
- C. Commissioning requires the participation of Division 26 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 01 19 10. Division 26 shall be familiar with all parts of Section 01 19 10 and the commissioning plan issued by the CxA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

#### 1.2 RESPONSIBILITIES

- A. Electrical Contractors: The commissioning responsibilities applicable to the electrical contractor are as follows (all references apply to commissioned equipment):
  - 1. Construction and Acceptance Phases
    - a. Attend a commissioning scoping meeting and other necessary meetings scheduled by the CxA to facilitate the Cx process.
    - b. Contractors shall provide normal cut sheets and shop drawing submittals to the CxA of commissioned equipment.
    - c. Provide additional requested documentation, prior to normal O&M manual submittals, to the CxA for development of startup and functional testing procedures.
      - 1) Typically this will include detailed manufacturer installation and startup, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be

used by the factory or field technicians shall be submitted to the CxA.

- 2) The CxA may request further documentation necessary for the commissioning process.
  - 3) This data request may be made prior to normal submittals.
- d. Provide a copy of the O&M manuals submittals of commissioned equipment, through normal channels, to the CxA for review.
  - e. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, drawings or equipment documentation is not sufficient for writing detailed testing procedures.
  - f. Provide assistance to the CxA in preparation of the specific functional performance test procedures as needed.
  - g. Develop a full startup and initial checkout plan using manufacturer's startup procedures and the pre-functional checklists from the CxA. Submit manufacturer's detailed startup procedures and the full startup plan and procedures and other requested equipment documentation to CxA for review.
  - h. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.
  - i. Address current O/E punch list items before functional testing.
  - j. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
  - k. Perform functional performance testing under the direction of the CxA for specified equipment in Section 01 19 10. Assist the CxA in interpreting the monitoring data, as necessary.
  - l. Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA and O/E and retest the equipment.
  - m. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
  - n. During construction, maintain as-built red-line drawings for all drawings and final CAD as-built for contractor-generated

coordination drawings. Update after completion of commissioning (excluding deferred testing). Prepare red-line as-built drawings for all drawings and final as-builts for contractor-generated coordination drawings.

- o. Provide training of the Owner's operating personnel as specified.
- p. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

2. Warranty Period

- a. Execute deferred functional performance testing, witnessed by the CxA, according to the specifications.
- b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

1.3 RELATED WORK

- A. Refer to Section 01 19 10 for a listing of all sections where commissioning requirements are found.
- B. Refer to contract documentation for systems to be commissioned and functional testing requirements.
- C. The Div. 26 contractor shall provide all labor and materials to fully support Div. 23 HVAC systems start up field quality control, pre-commissioning and commissioning. The Div. 26 contractor shall perform all required electrical portions of the Div. 23 commissioning. As part of this requirement, indicate by signature when check list items are complete where so indicated in the Div. 23 checklists.
- D. Coordinate all provisions and installations of Div. 26 with the hardware schedule indicated on the Design drawings.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Division 26 shall provide all test equipment necessary to fulfill the testing requirements of this Division.
- B. Refer to Section 01 19 10 for additional Division 26 requirements.

## PART 3 - EXECUTION

### 3.1 SUBMITTALS

- A. Division 26 shall provide submittal documentation relative to commissioning to the CxA as requested by the CxA. Refer to Section 01 19 10 for additional Division 26 requirements.

### 3.2 STARTUP

- A. The electrical contractors shall follow the startup and initial checkout procedures listed in the Responsibilities list in this section and in 01 19 10. Division 26 has startup responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning agent or Owner.
- B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems, or sub-systems at the discretion of the CxA. Beginning system testing before full completion does not relieve the Contractor of responsibility for fully completing the system as soon as possible.

### 3.3 FUNCTIONAL PERFORMANCE TESTS

- A. Refer to contract documentation for a list of systems to be commissioned.

### 3.4 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS

- A. Refer to Section 01 19 10 for specific details on non-conformance issues relating to pre-functional checklists and tests.
- B. Refer to Section 01 19 10 for issues relating to functional performance tests.

### 3.5 OPERATIONS AND MAINTENANCE (O&M) MANUALS

- A. Division 26 shall compile and prepare documentation for all equipment and systems covered in Division 26 and deliver to the owner for inclusion in the O&M manuals.
- B. The CxA shall receive a copy of the O&M manuals for concurrent review.

### 3.6 TRAINING OF OWNER PERSONNEL

- A. The contractor team shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Section 01 19 10 for additional details.

- B. The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Section 01 19 10 for additional details.
- C. Electrical Contractor: The electrical contractor shall have the following training responsibilities:
1. Provide the CxA with a training plan eight (8) weeks before the planned training according to the outline described in Section 01 19 10.
  2. Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.
  3. Training shall start with classroom sessions, if necessary, followed by hands on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
  4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
  5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the startup technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.
  6. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
  7. Training shall include:
    - a. Use the printed installation, operation and maintenance instruction material included in the O&M manuals.
    - b. Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include startup, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
    - c. Discuss relevant health and safety issues and concerns.
    - d. Discuss warranties and guarantees.

- e. Cover common troubleshooting problems and solutions.
  - f. Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
  - g. Discuss any peculiarities of equipment installation or operation.
  - h. The format and training agenda in Guidelines for Commissioning HVAC Systems, ASHRAE, Guideline 0-2005 is recommended.
  - i. Classroom sessions shall include the use of overhead projections, slides, video and audio taped material as might be appropriate.
- 8. Hands-on training shall include startup, operation in all modes possible, including manual, shut-down and any emergency procedures and maintenance of all pieces of equipment.
  - 9. The electrical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
  - 10. Training shall occur after functional testing is complete, unless approved otherwise by the Project Manager.
  - 11. Duration of Training: The electrical contractor shall provide training on each piece of equipment according to the individual specification sections.
  - 12. Videotaping as described in Section 01 19 10.

### 3.7 DEFERRED TESTING

- A. Refer to Section 01 19 10 for requirements of deferred testing.

### 3.8 WRITTEN WORK PRODUCTS

- A. Written work products of Contractors will consist of the startup and initial checkout plan described in Section 01 19 10 and the filled out startup and initial checkout.

END OF SECTION 260800

## SECTION 260913 – ELECTRICAL SUBMETERING 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.

#### 1.2 SUMMARY

- A. The intent of this project is to replace the existing electrical submetering system with an in-kind system that is integrated into the existing Schneider Powerlogic Monitoring System serving the Warehouse.
- B. Section includes Owner's electricity submeters used to manage the electrical power system.

#### 1.3 DEFINITIONS

- A. KY or KYZ Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity (kWh) that is based on a relay opening and closing in response to the rotation of the disk in the meter. Electronic meters generate pulses electronically.

#### 1.4

- A. Product Data:
  - 1. For each type of meter.
  - 2. For metering infrastructure components.
  - 3. For metering software.
- B. Shop Drawings: For electricity-metering equipment.
  - 1. Include elevation views of front panels of control and indicating devices and control stations.
  - 2. Include diagrams for power, signal, and control wiring.
  - 3. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
  - 4. Include series-combination rating data for modular meter centers with main disconnect device.
  - 5. 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 used. Describe characteristics of network and other data communication lines.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit evidence that meters are compatible with connected IP network systems specified in
  - 1. Show interconnecting signal and control wiring, and interface devices to show compatibility of meters.
  - 2. For reporting and billing interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.
- B. Qualification Data: For testing agency.
- C. Field quality-control reports.
- D. Sample Warranty: For special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Include the following:
  - 1. Application and operating software documentation.
  - 2. Software licenses.
  - 3. Software service agreement.
  - 4. Device address list.
  - 5. Hard copies of manufacturer's operating specifications, user's guides for software and hardware, and PDF files on a USB storage device of hard-copy Submittal.
  - 6. Meter data sheet for each meter, listing nameplate data and serial number, accuracy certification, and test results.
  - 7. Meter installation and billing software startup report.

#### 1.7 FIELD CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
  - 1. Owner shall be notified and issued written permission no fewer than two days in advance of proposed interruption of electrical service.

#### 1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An NRTL.



## 1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of metering equipment that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Damage from transient voltage surges.
  - 2. Warranty Period: Cost to repair or replace any parts for two years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 BASIS OF DESIGN MANUFACTURER

- A. Schneider PowerLogic iEM3000 Series Meters

### 2.2 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 916.

### 2.3 ELECTRICITY METERS

- A. System Description: Able to meter designated activity loads, with or without external alarm, control, and communication capabilities, or other optional features.
  - 1. Comply with ANSI C12.1 and ANSI C12.20, 0.2 accuracy class.
  - 2. Ambient Temperature: Minus 22 deg F to plus 158 deg F
  - 3. Humidity: Zero to 95 percent, noncondensing.
  - 4. Capacities and Characteristics: Refer to drawings for schedule of meters.
- B. General Requirements for Meters:
  - 1. Billing Meters Accuracy: 0.2 percent of reading, complying with ANSI C12.20.
  - 2. Certify that meters comply with ANSI C12.20 requirements by a laboratory accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology (NIST). The laboratory shall use test equipment that is certified annually and is traceable to NIST standards.
  - 3. Enclosure: Supplied by meter manufacturer, NEMA 250, Type 1 minimum, with provisions for locking or sealing.
  - 4. Identification: Comply with requirements in Section 260553 "Identification for Electrical Systems."
  - 5. Onboard Nonvolatile Data Storage: kWh, until reset.

6. Sensors: Current-sensing type, supplied by electronic meter manufacturer, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.
  - a. Type: Split and solid core, complying with recommendation of meter manufacturer.
- C. kWh Meter: Electronic Single-phase and three-phase meters, measuring electricity use.
  1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
  2. Display: LCD with characters not less than 0.25 inch high, indicating accumulative kWh and current kilowatt load. Retain accumulated kWh in a nonvolatile memory, until reset.
  3. Display: Digital electromechanical counter, indicating accumulative kWh.
- D. Remote Reading Options:
  1. TCP/IP adapter.
- E. Current-Transformer Cabinet: Size and configuration as recommended by metering equipment manufacturer for use with indicated connected feeder and sensors.
- F. Data Transmission Cable: Comply with requirements in Section 271000.
- G. Software: New devices shall be added to the existing Schneider Power Logic Monitoring system.
  1. Utility Cost Allocation: Automatically import electricity-usage records to allocate electricity demand costs for the following:
    - a. At least 15 tenants or activities.
  2. Activity Billing Software: Automatically import electricity-usage records to automatically compute and prepare electricity-use statements and invoices based on electricity use and peak demand. Maintain separate directory for each allocation. Prepare summary reports in user-defined formats and time intervals.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Comply with equipment installation requirements in NECA 1.
- B. Install meters to replace existing meters in size, voltage and rating.
- C. Install modular meter center according to switchboard installation requirements in NECA 400.
- D. Wiring Method:
  1. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
  2. Install CAT6 cable for control and signal transmission conductors

3. Minimum conduit size shall be  $\frac{3}{4}$ ".

### 3.2 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
  1. Series Combination Warning Label: Self-adhesive labels, with text as required by NFPA 70.
  2. Equipment Identification Labels: Self-adhesive labels with clear protective overlay. For residential meters, provide an additional card holder suitable for typewritten card with occupant's name.

### 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Tests and Inspections:
  1. Equipment and Software Setup:
    - a. Set meter date and time clock.
    - b. Test, calibrate, and connect pulse metering system.
    - c. Set and verify billing demand interval for demand meters.
    - d. Report settings and calibration results.
    - e. Set up reporting and billing software, insert billing location names and initial constant values and variable needed for billing computations.
  2. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
  3. Turn off circuits supplied by metered feeder and secure them in off condition.
  4. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
  5. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
  6. Generate test report and billing for each tenant or activity from the meter reading tests.
- D. Electricity metering will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.4 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
  - 1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's clerical and maintenance personnel to use, adjust, operate, and maintain the electronic metering and billing software.

END OF SECTION 262713

## SECTION 260943.23

### LIGHTING CONTROLS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. The intent of this project is to replace the existing relay-based lighting control system with an in-kind system and to integrate operation and control of the system into the proposed building automation system
- B. Section Includes: Control panels using mechanically held relays for TV receptacle load control and lighting control.

##### 1.03 DEFINITIONS

- A. IP: Internet protocol.
- B. 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.

##### 1.04 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 control modules, power distribution components, relays, manual switches and plates, and conductors and cables.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - 3. Sound data including results of operational tests of central dimming controls.
  - 4. Operational documentation for software and firmware.
- B. Shop Drawings: For each relay panel 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. Shop drawings of existing panels and enclosures to be re-used.
  - 4. Detail wiring partition configuration, current, and voltage ratings.
  - 5. Short-circuit current rating of relays.
  - 6. Address Drawing: Reflected ceiling plan and floor plans, showing connected fixtures and wiring devices, address for each fixture and wiring device, and control groups. Base plans on construction plans, using the same legend, symbols, and schedules.

7. Point List and Data Bus Load: Summary list of all control devices, sensors, ballasts, and other loads. Include percentage of rated connected load and device addresses.
8. Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.
9. 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.

#### 1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit evidence that relay controls are compatible with connected monitoring and control devices
  1. Show interconnecting signal and control wiring, and interface devices that prove compatibility of inputs and outputs.
- B. Qualification Data: For testing agency.
- C. Field quality-control reports.
- D. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.
- E. Sample Warranty: For manufacturer's special warranty.

#### 1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For controls to include in emergency, operation, and maintenance manuals.
- B. Software and Firmware Operational Documentation:
  1. Software operating and upgrade manuals.
  2. Program Software Backup: On USB drive and username and password for manufacturer's support website.
  3. Device address list.
  4. Printout of software application and graphic screens.
  5. Testing and adjusting of panic and emergency power features.

#### 1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare Attic Stock shall be EXCLUDED from bid pricing. Contractor shall review required spare parts & attic stock with Owner prior to project turnover.

#### 1.08 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
  1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Handle and prepare panels for installation according to NECA 407.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of the lighting control system that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Damage from transient voltage surges.
  - 2. Warranty Period: Cost to repair or replace any parts for two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Sequence of Operations: Input signal from field-mounted manual switches, time-of-day signals, occupancy sensors or digital signal sources, shall open or close one or more control relays in the control panels. Any combination of inputs shall be programmable to any number of control relays.
- B. Surge Protective Device: Factory installed as an integral part of control components or field-mounted surge suppressors complying with UL 1449, SPD Type 2.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.
- E. Comply with UL 916.

2.02 REMOTELY CONTROLLED LIGHTING PANELS

- A. Manufacturers: Lighting Controls shall be manufactured by Electronic Theatre Controls (ETC) or Intelligent Lighting Control (ILC) or approved equals by engineer. Substitutions shall be submitted at least 15 days prior to bid for review and approval.
- B. Description: Standalone control panel using mechanically latched relays to control lighting and appliances.
- C. Control Panel:
  - 1. A single enclosure with incoming lighting branch circuits, control circuits, switching relays, and on-board timing and control unit.
  - 2. A vertical barrier separating line voltage branch circuits from control wiring.
- D. Control Unit: Contain the power supply and electronic control for operating and monitoring individual relays.
  - 1. Timing Unit:
    - a. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.

- b. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
    - c. Four independent schedules, each having 24 time periods.
    - d. Schedule periods settable to the minute.
    - e. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
    - f. 10 special date periods.
  - 2. Sequencing Control with Override:
    - a. Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.
    - b. Sequencing control shall operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.
    - c. Override control shall allow any relay connected to it to be switched on or off by a field-deployed manual switch or by an automatic switch, such as an occupancy sensor.
    - d. Override control "blink warning" shall warn occupants approximately five minutes before actuating the off sequence.
  - 3. Nonvolatile memory shall retain all setup configurations. After a power failure, the controller shall automatically reboot and return to normal system operation, including accurate time of day and date.
- E. Relays: Electrically operated, mechanically held single-pole switch, rated at 20 A at 120-V tungsten, 30 A at 277-V ballast, 1.5 hp at 120 V, and 3 hp at 277 V. Short-circuit current rating shall be not less than 14 kA. Control shall be three-wire, 24-V ac.
- F. Power Supply: NFPA 70, Class 2, sized for connected equipment, plus 20 percent spare capacity. Powered from a dedicated branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, low-voltage inputs, field-installed occupancy sensors, and photo sensors.
- G. Operator Interface:
- 1. Integral alphanumeric keypad and digital display, and intuitive drop-down menus to assist in programming.
  - 2. Log and display relay on-time.
  - 3. Connect relays to one or more time and sequencing schemes.
  - 4. GUI: Integration with iBMS graphics package to provide seamless visualization, operation and manipulation of lighting controls in conjunction with automatic temperature controls, AV, IT and other systems required for various stadium activities.

## 2.03 MANUAL SWITCHES AND PLATES

- A. Push-Button Switches: Modular, momentary contact, three wire, for operating one or more relays and to override automatic controls.
- 1. Match color and style specified in Section 262726 "Wiring Devices."
  - 2. Integral green LED pilot light to indicate when circuit is on.
  - 3. Internal white LED locator light to illuminate when circuit is off.
- B. Wall Plates: Single and multigang plates as specified in Section 262726 "Wiring Devices."
- C. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.



## 2.04 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors. Comply with manufacturer's recommendations for control and communication cabling.
- C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

## 2.05 ENCLOSURES

- A. Enclosures in dry locations shall be NEMA 1.
- B. Enclosures to be reused shall be cleaned on the inside and repainted on the outside.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Receive, inspect, handle, and store panels according to NECA 407.
- B. Examine panels before installation. Reject panels that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panels for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway 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.

### 3.03 PANEL INSTALLATION

- A. Comply with NECA 1.
- B. Install and/or replace panels and accessories according to NECA 407.

- C. For new cabinets, mount top of trim a maximum of 90 inches above finished floor, unless otherwise indicated.
- D. For new cabinets, mount panel cabinet plumb and rigid without distortion of box.
- E. Install filler plates in unused spaces.

### 3.04 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- C. Create a directory to indicate loads served by each relay; incorporate Owner's final room designations. Obtain approval before installing. Use a PC and printer to create directory; hand-written directories are unacceptable.
- D. Control Panel Nameplates: Label each panel with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.05 PROGRAMMING AND INTEGRATION

- A. Provide initial system set up and integration with BAS system over BACnet IP.
- B. Initial set up shall include identification and labeling of all relays.
- C. Set up shall include the creation of a database of the following parameters associated with each relay: source panel and circuit number; controlled lighting fixture type, quantity & location; controlled TV quantity and location; externally triggered lighting system quantity and location; group assignment; scene assignment; current status and active schedule.
- D. Set up shall include the assignment of all relays to groups and scenes as directed by the Owner. The current system has approximately 300 groups, with a maximum of 350 groups to be identified and implemented into the new system.
- E. Set up shall include the creation of 24 complete scene templates of lighting control as directed by the Owner. These scenes shall be integrated with the automatic temperature controls to provide a common interface for scheduling a variety of events, in addition to game day.
- F. Provide integration with the GUI provided as part of the BMS platform upgrade. That system will consist of interactive color-graphics with pull-down menu, active content and the ability to create lighting system graphics. Graphically indicate the lighting and lighting control assets on the system floor plans. Graphics for relay panels, dimmer panels and local control units shall be selectable active links for re-directing user to the associated level graphics screen. The status and associations for each relay or dimmer shall be accessible by drilling down into the lighting control panel directories or by selecting objects or areas on the floor plans.

### 3.06 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. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test for relays described below and surge suppressors. Certify compliance with manufacturer's test parameters.
    - a. Relay Tests:
      - 1) Compare nameplate with Drawings and Specifications.
      - 2) Inspect physical and mechanical conditions.
      - 3) Inspect anchorage and alignment.
      - 4) Verify that the units are clean.
      - 5) Operate the relay to ensure proper electrical operation.
      - 6) Inspect bolted electrical connections for high resistance using one or more of the following methods:
        - a) A low-resistance ohmmeter.
        - b) Verify tightness of bolted electrical connections by calibrated torque wrench.
        - c) Thermographic survey.
    - b. Surge Suppressor Tests:
      - 1) Compare nameplate with the Contract Documents.
      - 2) Inspect physical and mechanical conditions.
      - 3) Inspect anchorage, alignment, grounding, and clearances.
      - 4) Verify that the units are clean.
      - 5) Inspect bolted electrical connections for high resistance using one or more of the following methods:
        - a) Low-resistance ohmmeter.
        - b) Verify tightness of bolted electrical connections by calibrated torque wrench.
      - 6) Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
      - 7) Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding tests.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- E. Control panel will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies control panels and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

### 3.07 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. Confirm correct communications wiring, initiate communications between panels, and program the control system according to approved configuration schedules, time-of-day schedules, and input override assignments.

3.08 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.09 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
  1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the control unit and operator interface.

END OF SECTION 260943.23

## 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.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Standard-grade receptacles, 125 V, 20 A.
  - 2. Twist-Locking receptacles, 125/250V, 20A , 30A & 50A
  - 3. Toggle switches, 120/277 V, 20 A.

##### 1.3 DEFINITIONS

- A. BAS: Building automation system.
- B. EMI: Electromagnetic interference.
- C. GFCI: Ground-fault circuit interrupter.
- D. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- E. RFI: Radio-frequency interference.
- F. SPD: Surge protective device.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

##### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

## 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. One of each type of device installed.

## PART 2 - PRODUCTS

### 2.1 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Comply with NFPA 70.
- C. RoHS compliant.
- D. Comply with NEMA WD 1.
- E. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
  - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
  - 2. Devices shall comply with requirements in this Section.
- F. Devices for Owner-Furnished Equipment:
  - 1. Receptacles: Match plug configurations.
  - 2. Cord and Plug Sets: Match equipment requirements.
- G. Device Color:
  - 1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
  - 2. Wiring Devices Connected to Essential Electrical System: Red.
- H. Wall Plate Color: Stainless Steel..
- I. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

### 2.2 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

- A. Duplex Receptacles, 125 V, 20 A:
  - 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. Eaton (Arrow Hart).
    - b. Hubbell Incorporated; Wiring Device-Kellems.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498 and FS W-C-596.

## 2.3 TWIST-LOCKING RECEPTACLES

### A. Twist-Lock, Single Receptacles, voltage and amperage as indicated.:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Eaton (Arrow Hart).
  - b. Hubbell Incorporated; Wiring Device-Kellems.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour/Legrand (Pass & Seymour).
2. Configuration: NEMA WD 6, Configuration L5-20R.
3. Standards: Comply with UL 498.

### B. Twist-Lock, Single Receptacles, 250 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Eaton (Arrow Hart).
  - b. Leviton Manufacturing Co., Inc.
  - c. Pass & Seymour/Legrand (Pass & Seymour).
2. Configuration: NEMA WD 6, Configuration L6-20R.
3. Standards: Comply with UL 498.

### C. Twist-Lock, Single Receptacles, 250 V, 30 A:

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. Eaton (Arrow Hart).
  - b. Hubbell Incorporated; Wiring Device-Kellems.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour/Legrand (Pass & Seymour).
2. Configuration: NEMA WD 6, Configuration L6-30R.
3. Standards: Comply with UL 498.

### D. Twist-Lock, Single Receptacles, 250 V, 50 A:

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. Eaton (Arrow Hart).
  - b. Hubbell Incorporated; Wiring Device-Kellems.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour/Legrand (Pass & Seymour).
2. Configuration: NEMA WD 6, Configuration L6-50R.
3. Standards: Comply with UL 498.

## 2.4 TOGGLE SWITCHES, 120/277 V, 20 A

### A. Single-Pole Switches, 120/277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Eaton (Arrow Hart).
  - b. Hubbell Incorporated; Wiring Device-Kellems.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour/Legrand (Pass & Seymour).
2. Standards: Comply with UL 20 and FS W-S-896.

## 2.5 WALL PLATES

- A. Single Source: Obtain wall plates from same manufacturer of wiring devices.
- B. Single and combination types shall match corresponding wiring devices.
  1. Plate-Securing Screws: Metal with head color to match plate finish.
  2. Material for Finished Spaces: 0.035-inch-thick, satin-finished, Type 302 stainless steel.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
  1. Protect installed devices and their boxes. 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 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 right 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 comply with 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. Pigtailling existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that 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, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by 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 down, 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.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

### 3.2 IDENTIFICATION

A. Comply with Section 26 0553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

- C. Essential Electrical System: Mark receptacles supplied from the essential electrical system to allow easy identification using engraved machine printing.

### 3.3 FIELD QUALITY CONTROL

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Perform the following tests and inspections:
  - 1. Test Instruments: Use instruments that comply with UL 1436.
  - 2. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. Tests for Receptacles:
  - 1. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
  - 2. Ground Impedance: Values of up to 2 ohms are acceptable.
  - 3. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
  - 4. Using the test plug, verify that the device and its outlet box are securely mounted.
  - 5. 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.
- D. Wiring device will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

**END OF SECTION 262726**

## SECTION 262813 - FUSES

### PART 1 - GENERAL

#### 1.01 RELATED DOCUMENTS

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

#### 1.02 SUMMARY

- A. Section Includes:
  - 1. Cartridge fuses rated 600 V ac and less for use in the following:
    - a. Control circuits.
    - b. Motor controls
    - c. Panelboards.
    - d. Switchgear.
    - e. Enclosed controllers.
    - f. Enclosed switches.
  - 2. Spare-fuse cabinets.

#### 1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
  - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
    - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
  - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
  - 3. Current-limitation curves for fuses with current-limiting characteristics.
  - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in electronic format suitable for use in SKM coordination software and in PDF format.
  - 5. Coordination charts and tables and related data.
  - 6. Fuse sizes for elevator feeders and elevator disconnect switches.

#### 1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 "Closeout Procedures," and Division 01 "Operation and Maintenance Data," include the following:
  - 1. Ambient temperature adjustment information.
  - 2. Current-limitation curves for fuses with current-limiting characteristics.
  - 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project.

Submit in electronic format suitable for use in SKM coordination software and in PDF format.

4. Coordination charts and tables and related data.

#### 1.05 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare Attic Stock shall be EXCLUDED from bid pricing. Contractor shall review required spare parts & attic stock with Owner prior to project turnover.

#### 1.06 FIELD CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F apply manufacturer's ambient temperature adjustment factors to fuse ratings.

### PART 2 - PRODUCTS

#### 2.01 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. Bussmann, an Eaton business.
  2. Littlefuse, Inc.
- B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

#### 2.02 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
  1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
  2. Type RK-5: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
  3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, time delay.
  4. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
  5. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
- 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 NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 FUSE APPLICATIONS

- A. Cartridge Fuses:
  - 1. Feeders: Class RK1, time delay.
  - 2. Motor Branch Circuits: Class RK5 time delay.
  - 3. Large Motor Branch (601-4000 A): Class L, time delay.
  - 4. Power Electronics Circuits: Class J, high speed.
  - 5. Other Branch Circuits: Class RK1, time delay.
  - 6. Control Transformer Circuits: Class CC, time delay, control transformer duty.
  - 7. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

### 3.03 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by the Construction Manager.

### 3.04 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

## SECTION 262816

### ENCLOSED SWITCHES AND CIRCUIT BREAKERS

#### PART 1 - GENERAL

##### 1.01 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.

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Fusible switches.
  - 2. Shunt trip switches.
  - 3. Molded-case circuit breakers (MCCBs).
  - 4. Enclosures.

##### 1.03 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
  - 1. Enclosure types and details for types other than NEMA 250, Type 1.
  - 2. Current and voltage ratings.
  - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
  - 4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
  - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
  - 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF and PRJ (SKM) electronic format.
- B. Shop Drawings: For enclosed switches and circuit breakers.
  - 1. Include plans, elevations, sections, details, and attachments to other work.
  - 2. Include wiring diagrams for power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.
  - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
    - b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF and PRJ (SKM) electronic format.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. **Spare Attic Stock shall be EXCLUDED from bid pricing. Contractor shall review required spare parts & attic stock with Owner prior to project turnover.**

1.08 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
  - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.09 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
  - 2. Altitude: Not exceeding 6600 feet.

1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with NFPA 70.

## 2.02 FUSIBLE SWITCHES

- 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.
  - 2. General Electric Company.
  - 3. SIEMENS Industry, Inc.; Energy Management Division.
  - 4. Square D; by Schneider Electric.
- B. Type HD, Heavy Duty:
  - 1. Single throw.
  - 2. Three pole.
  - 3. 240 and 600-V ac.
  - 4. 600 A and smaller.
  - 5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
  - 6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
  - 4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 240-V ac
  - 5. Hookstick Handle: Allows use of a hookstick to operate the handle.
  - 6. Lugs: Mechanical type, suitable for number, size, and conductor material.

## 2.03 SHUNT TRIP SWITCHES

- 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. Bussmann, an Eaton business.
  - 2. Littelfuse, Inc.
- B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with Class J fuse block and 200-kA interrupting and short-circuit current rating.
- C. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: 600-V ac, 100A; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, with clips or bolt pads to



- accommodate specified fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer of enough capacity to operate shunt trip, pilot, indicating and control devices.
- E. Accessories:
1. Oiltight key switch for key-to-test function.
  2. Oiltight green ON pilot light.
  3. Isolated neutral lug; 100 percent rating.
  4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
  5. Form C alarm contacts that change state when switch is tripped.
  6. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.
  7. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  8. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
  9. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 240-V ac.
  10. Hookstick Handle: Allows use of a hookstick to operate the handle.
  11. Lugs: Mechanical type, suitable for number, size, and conductor material.

## 2.04 MOLDED-CASE CIRCUIT BREAKERS

- 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.
  2. General Electric Company.
  3. SIEMENS Industry, Inc.; Energy Management Division.
  4. Square D; by Schneider Electric.
- B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
- C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.
- D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated.
- E. MCCBs shall be equipped with a device for locking in the isolated position.

- F. Lugs shall be suitable for 194 deg F rated wire, sized according to the 167 deg F temperature rating in NFPA 70.
- G. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.
- H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
  - 1. Instantaneous trip.
  - 2. Long- and short-time pickup levels.
  - 3. Long- and short-time time adjustments.
  - 4. Ground-fault pickup level, time delay, and I-squared t response.
- K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- L. Features and Accessories:
  - 1. Standard frame sizes, trip ratings, and number of poles.
  - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
  - 3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
  - 4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
  - 5. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
  - 6. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.
  - 7. Accessory Control Power Voltage: Integrally mounted, self-powered 120-V ac.

## 2.05 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1); gray baked enamel paint, electrodeposited on cleaned, phosphatized galvanized steel for interior dry locations and NEMA 250 Types 3R for exterior locations
- C. Operating Mechanism: The circuit-breaker operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
  - 8. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

### 3.02 PREPARATION

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  - 1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electric service.
  - 2. Indicate method of providing temporary electric service.
  - 3. Do not proceed with interruption of electric service without Construction Manager's written permission.
  - 4. Comply with NFPA 70E.

### 3.03 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
  - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1
  - 2. Outdoor Locations: NEMA 250, Type 3R

### 3.04 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in fusible devices.
- F. Comply with NFPA 70 and NECA 1.

### 3.05 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

### 3.06 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.
- D. Tests and Inspections for Switches:
  - 1. Visual and Mechanical Inspection:
    - a. Inspect physical and mechanical condition.
    - b. Inspect anchorage, alignment, grounding, and clearances.
    - c. Verify that the unit is clean.
    - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
    - e. Verify that fuse sizes and types match the Specifications and Drawings.
    - f. Verify that each fuse has adequate mechanical support and contact integrity.
    - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
      - 1) Use a low-resistance ohmmeter.
        - a) 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) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
        - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
    - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
    - i. Verify correct phase barrier installation.
    - j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
  - 2. Electrical Tests:
    - a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
    - b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
    - c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in ac-

cordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

- d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
- e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

E. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:

- a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
- b. Inspect physical and mechanical condition.
- c. Inspect anchorage, alignment, grounding, and clearances.
- d. Verify that the unit is clean.
- e. Operate the circuit breaker to ensure smooth operation.
- f. Inspect bolted electrical connections for high resistance using one of the two following methods:
  - 1) Use a low-resistance ohmmeter.
    - a) 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) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
    - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
- g. Inspect operating mechanism, contacts, and chutes in unsealed units.
- h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
- c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components,

follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.

- e. Determine the following by primary current injection:
  - 1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
  - 2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
  - 3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
  - 4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.
- f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.
- g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
- h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
- i. Verify operation of charging mechanism. Investigate units that do not function as designed.
- 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- 4. Perform the following infrared scan tests and inspections and prepare reports:
  - a. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
  - b. 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.
- 5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports.
  - 1. Test procedures used.
  - 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
  - 3. List deficiencies detected, remedial action taken, and observations after remedial action.

### 3.07 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262816

## SECTION 262913.03

### MANUAL AND MAGNETIC MOTOR CONTROLLERS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Section Includes:

- 1. Manual motor controllers.
- 2. Enclosed full-voltage magnetic motor controllers.
- 3. Combination full-voltage magnetic motor controllers.
- 4. Enclosures.
- 5. Accessories.
- 6. Identification.

##### 1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. NC: Normally closed.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SCPD: Short-circuit protective device.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each type of magnetic controller.
  - 1. Include plans, elevations, sections, and mounting details.



2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
3. Wire Termination Diagrams and Schedules: Include diagrams for signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Product Schedule: List the following for each enclosed controller:

1. Each installed magnetic controller type.
2. NRTL listing.
3. Factory-installed accessories.
4. Nameplate legends.
5. SCCR of integrated unit.
6. For each combination magnetic controller include features, characteristics, ratings, and factory setting of the SCPD and OCPD.
  - a. Listing document proving Type 2 coordination.
7. For each series-rated combination state the listed integrated short-circuit current (withstand) rating of SCPD and OCPDs by an NRTL acceptable to authorities having jurisdiction.

## 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For magnetic controllers to include in operation and maintenance manuals.

1. Include the following:
  - a. Routine maintenance requirements for magnetic controllers and installed components.
  - b. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
  - c. Manufacturer's written instructions for setting field-adjustable overload relays.
  - d. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Attic Stock shall be EXCLUDED from bid pricing. Contractor shall review required spare parts & attic stock with Owner prior to project turnover.

## 1.8 QUALITY ASSURANCE

### A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- ### A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

## 1.10 FIELD CONDITIONS

### A. Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 23 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet for electromagnetic and manual devices.

## PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

- ### A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- ### B. UL Compliance: Fabricate and label magnetic motor controllers to comply with UL 508 and UL 60947-4-1.
- ### C. NEMA Compliance: Fabricate motor controllers to comply with ICS 2.

## 2.2 MANUAL MOTOR CONTROLLERS

### A. Motor-Starting Switches (MSS): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Eaton.
  - b. General Electric Company.
  - c. SIEMENS Industry, Inc.; Energy Management Division.
  - d. Square D; by Schneider Electric.
2. Standard: Comply with NEMA ICS 2, general purpose, Class A.
3. Configuration: Nonreversing.
4. Surface mounting.
5. Red pilot light.

## 2.3 ENCLOSED FULL-VOLTAGE MAGNETIC MOTOR CONTROLLERS

- A. Description: Across-the-line start, electrically held, for nominal system voltage of 600-V ac and less.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton.
  - 2. General Electric Company.
  - 3. SIEMENS Industry, Inc.; Energy Management Division.
  - 4. Square D; by Schneider Electric.
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration: Nonreversing.
- E. Contactor Coils: Pressure-encapsulated type.
  - 1. Operating Voltage: Manufacturer's standard, unless indicated.
- F. Control Power:
  - 1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
    - a. Spare CPT Capacity as Indicated on Drawings: 50VA.
- G. Overload Relays:
  - 1. Solid-State Overload Relay:
    - 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.

## 2.4 COMBINATION FULL-VOLTAGE MAGNETIC MOTOR CONTROLLER

- A. Description: Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton.
  - 2. General Electric Company.
  - 3. SIEMENS Industry, Inc.; Energy Management Division.
  - 4. Square D; by Schneider Electric.
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration: Nonreversing.

E. Contactor Coils: Pressure-encapsulated type.

1. Operating Voltage: Manufacturer's standard, unless indicated.

F. Control Power:

1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
  - a. Spare CPT Capacity as Indicated on Drawings: 50VA.

G. Overload Relays:

1. Solid-State Overload Relay:
  - 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.

H. Fusible Disconnecting Means:

1. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

I. Nonfusible Disconnecting Means:

1. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.5

A. MCCB Disconnecting Means:

1. UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse-time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
2. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.6 ENCLOSURES

A. Comply with NEMA 250, type designations as indicated on Drawings, complying with environmental conditions at installed location.

B. The construction of the enclosures shall comply with NEMA ICS 6.

C. Controllers in hazardous (classified) locations shall comply with UL 1203.

2.7 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty, except as needed to match enclosure type. Heavy-duty or oil-tight where indicated in the controller schedule.
    - a. Push Buttons: As indicated in the controller schedule.
    - b. Pilot Lights: As indicated in the controller schedule.
  2. Elapsed Time Meters: Heavy duty with digital readout in hours; resettable.
  3. Meters: Panel type, 2-1/2-inch minimum size with 90- or 120-degree scale and plus or minus two percent accuracy. Where indicated, provide selector switches with an off position.
- B. Motor protection relays shall be with solid-state sensing circuit and isolated output contacts for hardwired connections.
1. Phase-failure.
  2. Phase-reversal, with bicolor LED to indicate normal and fault conditions. Automatic reset when phase reversal is corrected.
  3. Under/overvoltage, operate when the circuit voltage reaches a preset value, and drop out when the operating voltage drops to a level below the preset value. Include adjustable time-delay setting.
- C. Breather assemblies, to maintain interior pressure and release condensation in Type 4 & Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- D. Space heaters, with NC auxiliary contacts, to mitigate condensation in Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- E. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

## 2.8 IDENTIFICATION

- A. Controller Nameplates: Laminated acrylic or melamine plastic signs, as described in Section 26 0553 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.
- B. Arc-Flash Warning Labels:
1. Comply with requirements in Section 26 0573 "Overcurrent Protective Device Study." Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.
    - a. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
      - 1) Location designation.
      - 2) Nominal voltage.
      - 3) Flash protection boundary.
      - 4) Hazard risk category.
      - 5) Incident energy.
      - 6) Working distance.

- 7) Engineering report number, revision number, and issue date.
- b. Labels shall be machine printed, with no field-applied markings.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

#### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 26 0529 "Hangers and Supports for Electrical Systems" unless otherwise indicated.
- C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- D. 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.
- E. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

#### 3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

#### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to 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. Tests and Inspections:
  - 1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.
  - 2. Visual and Mechanical Inspection:
    - a. Compare equipment nameplate data with drawings and specifications.
    - b. Inspect physical and mechanical condition.

- c. Inspect anchorage, alignment, and grounding.
  - d. Verify the unit is clean.
  - e. Inspect contactors:
    - 1) Verify mechanical operation.
    - 2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
  - f. Motor-Running Protection:
    - 1) Verify overload element rating is correct for its application.
    - 2) If motor-running protection is provided by fuses, verify correct fuse rating.
  - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
    - 1) Use a low-resistance ohmmeter. Compare bolted connection resistance values with values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
  - h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
3. Electrical Tests:
- a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation resistance less than those of this table or manufacturer's recommendations shall be investigated and corrected.
  - b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
  - c. Test motor protection devices according to manufacturer's published data.
  - d. Perform operational tests by initiating control devices.
4. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove all necessary covers prior to the inspection.
- a. Comply with the recommendations of NFPA 70B, "Testing and Test Methods" Chapter, "Infrared Inspection" Article.
  - b. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of each motor controller.
  - c. Report of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used, and lists the following results:
    - 1) Description of equipment to be tested.
    - 2) Discrepancies.
    - 3) Temperature difference between the area of concern and the reference area.
    - 4) Probable cause of temperature difference.
    - 5) Areas inspected. Identify inaccessible and unobservable areas and equipment.
    - 6) Load conditions at time of inspection.
    - 7) Photographs and thermograms of the deficient area.
    - 8) Recommended action.

- d. Equipment: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1C at 30C. The equipment shall detect emitted radiation and convert detected radiation to a visual signal.
- e. Act on inspection results and recommended action, and considering the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

E. Motor controller will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

### 3.5 SYSTEM FUNCTION TESTS

A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality control tests have been completed and all components have passed specified tests.

- 1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
- 2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
- 3. Verify the correct operation of sensing devices, alarms, and indicating devices.

B. Motor controller will be considered defective if it does not pass the system function tests and inspections.

C. Prepare test and inspection reports.

### 3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear.

END OF SECTION 26



## SECTION 263213.13 - DIESEL-ENGINE-DRIVEN GENERATOR CONTROLS

### 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. Scope of project includes the upgrade of the existing engine generator control with a new monitoring and control panel capable of digital communication with the proposed building automation system upgrades.
- B. Section Includes:
  - 1. Control and monitoring.
  - 2. Generator, exciter, and voltage regulator.

#### 1.3 DEFINITIONS

- A. EPS: Emergency power supply.
- B. EPSS: Emergency power supply system.
- C. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include Features and Performance.
  - 2. Communication protocol
  - 3. Field Connections
- B. Shop Drawings:
  - 1. Include plans and elevations for engine generator control panel.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for engine generators and functional relationship between all electrical components.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and testing agency.
- B. Field quality-control reports.
- C. Warranty: For special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For engine generator control upgrade to include in emergency, operation, and maintenance manuals.
  1. Include the following:
    - a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
    - b. Operating instructions laminated and mounted adjacent to generator location.
    - c. Training plan.

#### 1.7 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 of each.
  2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
  3. Tools: Each tool listed by part number in operations and maintenance manual.

#### 1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Testing Agency Qualifications: Accredited by NETA.
  1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

## 1.9 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generator control panel and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 5 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Caterpillar
- B. Source Limitations: Obtain packaged engine generator controls and auxiliary components from single source.

### 2.2 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance:
1. Comply with NFPA 70.
  2. Comply with NFPA 110 requirements for Level 1 EPSS.
- B. UL Compliance: Comply with UL 2200.
- C. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
1. Ambient Temperature: 41 to 104 deg F
  2. Relative Humidity: Zero to 95 percent.
  3. Altitude: Sea level to 1000 feet.

### 2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

- A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.
- B. Engine Generator Performance:
1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
  2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
  3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.

4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time:
  - a. Comply with NFPA 110, Type 10 system requirements.
  - b. 10 seconds.

C. Parallel Engine Generators:

1. Automatic regulation, automatic connection to a common bus, and automatic synchronization, with manual controls and instruments to monitor and control paralleling functions.
2. Protective relays required for equipment and personnel safety.
3. Paralleling suppressors to protect excitation systems.
4. Reverse power protection.
5. Loss of field protection.

2.4 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate control systems initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.
- B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts engine generator. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.
- C. Comply with UL 508A.
- D. Configuration:
  1. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel enclosure. Panel shall be powered from the engine generator battery.

- a. Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6.

E. Control and Monitoring Panel:

1. Digital engine generator controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
2. Instruments: Located on the control and monitoring panel and viewable during operation.
  - a. Engine lubricating-oil pressure gage.
  - b. Engine-coolant temperature gage.
  - c. DC voltmeter (alternator battery charging).
  - d. Running-time meter.
  - e. AC voltmeter, for each phase.
  - f. AC ammeter, for each phase.
  - g. AC frequency meter.
  - h. Generator-voltage adjusting rheostat.
3. Controls and Protective Devices: Controls, shutdown devices, and common alarm indication, including the following:
  - a. Cranking control equipment.
  - b. Run-Off-Auto switch.
  - c. Control switch not in automatic position alarm.
  - d. Overcrank alarm.
  - e. Overcrank shutdown device.
  - f. Low-water temperature alarm.
  - g. High engine temperature prealarm.
  - h. High engine temperature.
  - i. High engine temperature shutdown device.
  - j. Overspeed alarm.
  - k. Overspeed shutdown device.
  - l. Low fuel main tank.
    - 1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for duration required
  - m. Coolant low-level alarm.
  - n. Coolant low-level shutdown device.
  - o. Coolant high-temperature prealarm.
  - p. Coolant high-temperature alarm.
  - q. Coolant low-temperature alarm.
  - r. Coolant high-temperature shutdown device.
  - s. EPS load indicator.
  - t. Battery high-voltage alarm.
  - u. Low cranking voltage alarm.
  - v. Battery-charger malfunction alarm.
  - w. Battery low-voltage alarm.
  - x. Lamp test.
  - y. Contacts for local and remote common alarm.

- z. Remote manual stop shutdown device.
- aa. Generator overcurrent-protective-device not-closed alarm.
- bb. Hours of operation.
- cc. Engine generator metering, including voltage, current, hertz, kilowatt, kilovolt ampere, and power factor.

F. Connection to Datalink:

- 1. Provide connections for datalink transmission of indications to remote data terminals via IP protocol over Ethernet data system.
- 2. Coordinate with work under Divisions 23 & 25 to provide generator system monitoring by the new BMS system.

G. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

- 1. Overcrank alarm.
- 2. Low water-temperature alarm.
- 3. High engine temperature prealarm.
- 4. High engine temperature alarm.
- 5. Low lube oil pressure alarm.
- 6. Overspeed alarm.
- 7. Low fuel main tank alarm.
- 8. Low coolant level alarm.
- 9. Low cranking voltage alarm.
- 10. Contacts for local and remote common alarm.
- 11. Audible-alarm silencing switch.
- 12. Air shutdown damper when used.
- 13. Run-Off-Auto switch.
- 14. Control switch not in automatic position alarm.
- 15. Fuel tank derangement alarm.
- 16. Fuel tank high-level shutdown of fuel supply alarm.
- 17. Lamp test.
- 18. Low-cranking voltage alarm.
- 19. Generator overcurrent-protective-device not-closed alarm.

H. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.

2.5 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Provide update exciter circuit to accommodate the updated engine monitoring and control panel

- C. Range: Provide extended range of output voltage by adjusting the excitation level.
- D. Enclosure: Dripproof.
- E. Instrument Transformers: Mounted within generator enclosure.
- F. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.
  - 1. Adjustment on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
  - 2. Maintain voltage within 15 percent on one step, full load.
  - 3. Provide anti-hunt provision to stabilize voltage.
  - 4. Maintain frequency within 5 percent and stabilize at rated frequency within 2 seconds.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.
- B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before EMCP installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
  - 1. Notify Owner no fewer than two working days in advance of proposed interruption of electrical service.
  - 2. Do not proceed with interruption of electrical service without Owner's written permission.

#### 3.3 INSTALLATION

- A. Comply with NECA 1 and NECA 404.
- B. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.
- C. Equipment Mounting:

1. Install engine generator control panels

### 3.4 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

### 3.5 IDENTIFICATION

- A. Identify system components according to Section 260553 "Identification for Electrical Systems."

### 3.6 FIELD QUALITY CONTROL

- A. Testing Agency:
  1. Engage a qualified testing agency to perform tests and inspections.
  2. Perform tests and inspections with the assistance of a factory-authorized service representative.
- B. Tests and Inspections:
  1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in first two subparagraphs below, as specified in NETA ATS. Certify compliance with test parameters.
    - a. Visual and Mechanical Inspection:
      - 1) Compare equipment nameplate data with Drawings and the Specifications.
      - 2) Inspect physical and mechanical condition.
      - 3) Inspect anchorage, alignment, and grounding.
      - 4) Verify that the unit is clean.
    - b. Electrical and Mechanical Tests:
      - 1) Perform insulation-resistance tests according to IEEE 43.
        - a) Machines Larger Than 200 hp (150 kW): Test duration shall be 10 minutes. Calculate polarization index.
      - 2) Test protective relay devices.
      - 3) Verify phase rotation, phasing, and synchronized operation as required by the application.
      - 4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.



- 5) Perform vibration test for each main bearing cap.
  - 6) Verify correct functioning of the governor and regulator.
- 2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
- C. Coordinate tests with tests for transfer switches and run them concurrently.
- D. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- E. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.
- F. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- G. Remove and replace malfunctioning units and retest as specified above.
- H. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.
- I. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

### 3.7 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's authorized service representative. Include quarterly preventive maintenance and exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Parts shall be manufacturer's authorized replacement parts and supplies.

### 3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION 263213.13

## SECTION 264313

### SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

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

##### 1.02 SUMMARY

- A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.
  - 1.

##### 1.03 DEFINITIONS

- A. Inominal: Nominal discharge current.
- B. MCOV: Maximum continuous operating voltage.
- C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.
- D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SPD: Surge protective device.
- H. VPR: Voltage protection rating.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - 2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For manufacturer's special warranty.

1.06 CLOSEOUT SUBMITTALS

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

1.07 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 GENERAL SPD REQUIREMENTS

- A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Comply with UL 1449.
- D. MCOV of the SPD shall be the nominal system voltage.

2.02 SUPPRESSOR

- 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. Square D; by Schneider Electric.
  - 2. Eaton.
  - 3. SIEMENS Industry, Inc.; Energy Management Division.
- B. SPDs: Comply with UL 1449, Type 1.
- C. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1
  - 4. SPDs with the following features and accessories:
    - a. Integral disconnect switch.
    - b. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
    - c. Indicator light display for protection status.
    - d. Form-C contacts rated at 5 A and 250-V ac one normally open and one normally closed, for remote monitoring of protection status.
    - e. Surge counter.
- D. Comply with UL 1283.
- E. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 320 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

- F. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
  - 1. Line to Neutral: 1200 V for 480Y/277 V.
  - 2. Line to Ground: 1200 V for 480Y/277 V.
  - 3. Line to Line: 2000 V for 480Y/277 V.

G. SCCR: Equal or exceed 200 kA.

H. Inominal Rating: 20 kA.

## 2.03 ENCLOSURES

- A. Indoor Enclosures: NEMA 250, Type 1.
- B. Outdoor Enclosures: NEMA 250, Type 3R.

## 2.04 CONDUCTORS AND CABLES

- A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Comply with NECA 1.
- B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.
- C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
- D. Use crimped connectors and splices only. Wire nuts are unacceptable.
- E. Wiring:
  - 1. Power Wiring: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
  - 2. Controls: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.02 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
  - 1. Compare equipment nameplate data for compliance with Drawings and Specifications.
  - 2. Inspect anchorage, alignment, grounding, and clearances.
  - 3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. An SPD will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.03 STARTUP SERVICE

- A. Complete startup checks according to manufacturer's written instructions.
- B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.

3.04 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 264313

## SECTION 271000 - TELECOMMUNICATIONS STRUCTURED CABLING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 REFERENCES

- A. Building Industry Consulting Services International (BiCSI), "Telecommunications Distributions Methods Manual," Thirteenth Edition.
- B. American National Standards Institute/Telecommunications Industry Association (ANSI/TIA)-568.2-D, "Commercial Building Telecommunications Wiring Standard"
- C. ANSI/TIA-569-D, "Commercial Building Standard for Telecommunications Pathways and Spaces"
- D. ANSI/TIA-606C, "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings"
- E. ANSI/TIA-607-C, "Commercial Building Grounding/Bonding Requirements"
- F. National Electrical Code (NEC), 2017 - National Fire Protection Agency (NFPA) 70
- G. Institute of Electrical and Electronic Engineers (IEEE) 802.3 Carrier Sense Multiple Access with Collision Detection (Ethernet 100BASE-T)
- H. Federal Communications Commission (FCC), Title 47, Code of Federal Regulations, Part 68.
- I. National Institution for Certification in Engineering Technologies (NICET)
- J. International Communications Industry Association (ICIA).

#### 1.3 SUMMARY

- A. Section Includes:
  - 1. UTP cabling.
  - 2. Coaxial cable (radio frequency video).
  - 3. Cable connecting hardware, patch panels, and cross-connects.

4. Telecommunications outlet/connectors.
5. Cable management system.
6. Cabling identification products.
7. Telecommunications Pathways.
8. Telecommunications mounting elements.

B. Bidding Requirements:

1. Bidder shall submit complete detailed proposals with line item cost representation for components and associated installation labor. Lump sum bids will not be accepted.
2. Bidders shall include as part of the bid response the following items:
  - a. Installation schedule with proposed manpower assignments.
  - b. Resumes for project manager and lead technician for this project.
  - c. BICSI RCDD certificate and registration number.
3. Bidders shall review associated electrical and telecommunications infrastructure drawings to verify that necessary conduit and floor boxes will be provided by others. Bidders shall understand and coordinate shared infrastructure locations for telecommunications outlets. The Owner will provide no additional infrastructure to support the telecommunications cabling systems Inside Plant (ISP) and Outside Plant (OSP). Any discrepancies with the identified infrastructure to support these systems should be questioned in the form of a request for information (RFI) during the bidding process. Be responsible for any additional infrastructure requirements after receipt of contract for this project. No wiremold or surface mounted raceways shall be approved on this project except where specifically identified in the contract drawings.
4. Unspecified Equipment and Material: Any item of equipment or material not specifically addressed on the drawings or in this document and required to provide a complete and functional Structured Cabling System shall be provided in a level of quality consistent with other specified items.

1.4 DEFINITIONS

- A. AFC: Above Finished Ceiling
- B. BICSI: Building Industry Consulting Service International

- C. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways
- D. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection
- E. EF: Entrance Facility
- F. EMI: Electromagnetic interference
- G. HC: Horizontal Cross Connect
- H. IDC: Insulation displacement connector
- I. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs)
- J. LAN: Local Area Network
- K. MC: Main Cross-connect
- L. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors
- M. NRTL: Nationally Recognized Testing Laboratory
- N. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates
- O. RCDD: Registered Communications Distribution Designer
- P. TR: Telecommunications Room

#### 1.5 SYSTEM DESCRIPTION

- A. Provide a complete and functioning Structured Cabling System inclusive of all hardware, software, and training to meet or exceed the performance features outlined in this document.
- B. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
  - 1. ANSI/ANSI/TIA-568.2-D requires that a minimum of two telecommunications outlet/connectors be installed for each work area.



2. A work area is approximately 100 sq. ft., and includes the components that extend from the telecommunications outlet/connectors to the station equipment.
  3. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
  4. Bridged taps and splices shall not be installed in the horizontal cabling.
  5. Splitters shall not be installed as part of the optical fiber cabling.
- C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet in the horizontal cross-connect.
- D. Communications equipment room shall provide the space to house the equipment for the backbone and horizontal cabling.

#### 1.6 PERFORMANCE REQUIREMENTS

- A. General Performance: The cabling system shall comply with transmission standards in ANSI/TIAANSI/TIA-568.2-D when tested according to the test procedures of this standard.

#### 1.7 SUBMITTALS

- A. Comply with requirements of Section 01 33 00 - Submittal Procedures.
- B. Submittal Data
1. Submittal data is to be submitted as a complete, single digital file. All documents shall be clearly legible. Each submittal shall contain the below in the following order:
    - a. Cover Sheet.
      - 1) Include name of supplying contractor and project name.
      - 2) Include submittal and revision number.
    - b. Detailed Bill of Materials.
      - 1) Include a listing of component quantities, equipment manufacturers, model numbers, and descriptions of each component being supplied and the specification paragraphs or drawing sheets that correspond to each product.

- 2) The bill of materials shall include page numbers for each product data sheet and be index referenced within the PDF file so that each product name is clickable, linked to the first page of the corresponding product data.
    - 3) Failure to provide this information will result in the rejection of submittals.
  - c. Product Data.
    - 1) Include a catalog sheet per product of equipment listed in the Detailed Bill of Materials, in the exact order as the Detailed Bill of Materials. Each catalog sheet shall describe mechanical, electrical and functional equipment specifications. The catalog sheet must also include an image of the product.
    - 2) Photocopy duplications of the manufacturer's original equipment catalog sheets will be allowed as long as they provide adequate clarity of both the printed word and graphics/pictures.
    - 3) If more than one product is shown on the catalog sheet the intended product must be denoted by either an arrow or highlight.
  - d. Authorized Distributor Certificate.
    - 1) Recently dated (within one year from submittal date) support letter from manufacturer stating that the supplying contractor is an Authorized Distributor of the product being supplied.
  - e. Prequalification Warrantee.
    - 1) Recently dated (within one year from submittal date) support letter from manufacturer stating that the supplying contractor is Authorized to obtain for the owner the Special Warranty for Cabling System and the Special Warranty for System Assurance.
  - f. Prequalification Certificate.
    - 1) Copy of the installing technician(s) certificate of completion from the manufacturer's training school for the equipment being provided.
2. Partial submittals, or submittals comprised of multiple PDF files, will not be accepted.

C. Shop Drawings

1. Prior to fabrication submit contractor-generated drawings for approval for all supplied systems. Shop Drawings are to be submitted on project standard full size and bound. Each shop drawing set is to include the below in the following order:
    - a. Title Sheet.
      - 1) Include a list of all drawings in the set and a symbols legend defining each symbol used in the package.
    - b. Video/CATV System Engineering
      - 1) Depict device location by room number and device type. Delineate cable types and cable pathway for both riser and horizontal distribution. Calculate db loss and outline levels for each splitter, tap, amplifier, and outlet.
    - c. Typical Outlet Details.
      - 1) Detail each typical outlet type to be installed. Include manufacturer specific plates, jacks, and an example of labeling. Note on the drawing the typical application of each outlet type, for example; standard office, computer lab, ceiling mounted wireless access location, etc.
    - d. Floor Plans.
      - 1) Show planned location for all elements and cable routing.
      - 2) Drawings should be at project standard scale clearly legible. Include outlet port numbers for each outlet.
  2. Resubmission of contract drawings does not constitute a complete shop drawings submittal and is unacceptable. Such submittals will be rejected.
- D. Product data and shop drawings must be submitted together in order to be reviewed.
- E. Samples shall be submitted for each typical outlet type to be installed, complete with colored jacks, finished faceplates, and sample labeling.
- F. Field quality-control reports.
1. Submit copy of project status reporting form.

## 1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
  - 1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings by an RCDD.
  - 2. Installation Supervision: Installation shall be under the direct supervision of Level 2 installer and manufactures certified installer, who shall be present at all times when work of this section is performed at project site. At a minimum, one half of remainder of the crew shall be registered technicians by the specified manufacturer as part of their Certified Installer Program.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame-Spread Index: 25 or less.
  - 2. Smoke-Developed Index: 50 or less.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Installing company shall be certified by manufactures in aspects of design, installation and testing of optical and Category rated metallic premise distribution systems, be a manufactures Value Added Reseller (VAR) in good standing, have a minimum of five (5) years' experience on similar Structured Cabling Systems (SCS), and have a Registered Communications Distribution Designer (RCDD) on staff.
- E. Telecommunications Pathways and Spaces: Comply with ANSI/TIAANSI/TIA-569-D.
- F. Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, 2017 ANSI/ANSI/TIA-606-C.
- G. Grounding: Comply with ANSI-J-STD-607-C.
- H. NFPA 70 – National Electric Code, latest edition.
- I. BICSI – Telecommunications Distribution Methods Manual, 13th Edition, 2015
- J. NEMA – VE-1 – Metal Cable Tray Systems, 2017
- K. NEMA – VE-2 – Metal Cable Tray Installation Guidelines, 2013

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
  - 1. Test optical fiber cable to determine the continuity of the strand end to end. Use an optical loss test set.
  - 2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
  - 3. Test each pair of UTP cable for open and short circuits.
- B. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Environmental Limitations: Do not deliver or install equipment frames and ladder racking until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.11 COORDINATION

- A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
  - 1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
  - 2. Record agreements reached in meetings and distribute them to other participants.
  - 3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
  - 4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other

communications, electronic safety and security, and related systems that share space in the equipment room.

- B. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.
- C. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.
- D. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

#### 1.12 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Patch-Panel Units: The greater of one (1) or 10% of total quantity of each type.
  - 2. Connecting Blocks: The greater of one (1) or 10% of total quantity of each type.
  - 3. Device Plates: The greater of ten (10) or 2% of total quantity of each type.

#### 1.13 WARRANTY

- A. Special Warranty for Cabling System: Manufactures warranty shall ensure against product defects; that approved cabling components exceed the specifications of ANSI/TIAANSI/TIA- 568.2-D and ISO/IEC IS 11801; exceed the attenuation and NEXT requirements of ANSI/TIA- TSB-67 and ISO/IEC IS 11801 for cabling links/channels; and that the installation will exceed the loss and bandwidth requirements of ANSI/TIA-TSB-67 and ISO/IEC IS 11801 for fiber links/channels. The warranty shall apply to passive SCS components.
  - 1. Warranty Period: 25 year Cabling System from date of Substantial Completion.
- B. Special Warranty for System Assurance: Manufactures warranty shall cover the failure of the wiring system to support the application which it was designed to support, as well as additional application(s) introduced in the future by recognized standards or user forums that recognize ANSI/TIAANSI/TIA-568.2-D or ISO/IEC IS 11801 component and link/channel specifications for cabling.
  - 1. Warranty Period: 25 year Applications Assurance from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

### 2.2 PATHWAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, and are limited to, the following:
  - 1. Basis of design: ERICO
  - 2. Approved equals by:
    - a. Cooper/BN-line
    - b. Hilti Inc.
- B. General Requirements: Comply with ANSI/TIAANSI/TIA-569-D.
- C. Cable Support: NRTL labeled. Cable support brackets in Telecommunications Rooms shall be designed to prevent degradation of cable performance and pinch points that could damage cable.
- D. Provide bend limiters, if not built into the cable support, to maintain cable type bend radius whenever cable exists pathways or makes transition between two pathways.
- E. Non-continuous cable supports shall be used in any area above the finished ceiling where cable tray is not available.
- F. Non-continuous cable supports
  - 1. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
  - 2. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; cULus Listed.
  - 3. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.

4. Non-continuous cable supports sized 1 5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.
  5. Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
  6. Non-continuous cable supports shall be ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64, CAT21SS, CAT32SS, CAT64SS; CAT-CMTM Double J-Hook CAT100CM; CAT-CMTM U-hook series CAT200CMLN, CAT300CMLN; and CAT- CMTM retainer CATRT200CM, CATRT300CM or approved equal.
- G. Non-continuous cable support assemblies from drop wire/ceiling
1. Fastener to wire/rod with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
  2. Acceptable products: ERICO CADDY CAT124Z34, CAT126Z34, CAT214Z34, CAT216Z34, CAT324Z34 or CAT326Z34; or approved equal.
- H. Non-continuous cable support assemblies from beam, flange
1. Fastener to beam or flange with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
  2. Acceptable products: ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64 with CADDY beam clamps and CADDY flange clips; or approved equal.
- I. Non-continuous cable support assemblies from C & Z Purlin
1. Fastener to C or Z purlin with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, cULus listed.
  2. Acceptable products: ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64 with CADDY Purlin hangers; or approved equal.
- J. Non-continuous cable support assemblies from wall, concrete, or joist
1. Fastener to wall, concrete, or joist with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, cULus listed.



2. Acceptable products: ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64, with CADDY angle bracket; or approved equal.

K. Non-continuous cable support assemblies from threaded rod

1. Fastener to threaded rod with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments, cULus Listed.
2. The multi-tiered support bracket shall have a static load limit of 300 lbs.
3. U-hooks and Double J-hook shall attach directly to threaded rod using standard nuts.
4. Acceptable products: ERICO CableCat™ J-hook, CAT12, CAT21, CAT32, CAT64 with CADDY CATHBA series; CAT-CMTM Double J-hook CAT100CM, CAT-CMTM Direct mount U-hook CAT200CMLN, CAT300CMLN; or AFAB series; or approved equal.

L. Raised floor non-continuous cable support assemblies

1. Fastener to raised (access) floor pedestal with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments; cULus Listed.
2. Acceptable products: ERICO CADDY CAT12CD1B, CAT21CD1B or CAT32CD1B; CAT64CD1B; or approved equal.

2.3 CONDUIT AND BOXES

A. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceways and Boxes." Flexible metal conduit shall not be used.

1. Outlet boxes shall be no smaller than 5 inches wide, 5 inches high, and 2.875 inches deep.

2.4 UTP CABLE

A. Manufacturers: Subject to compliance with the specified requirements, provide products by one of the following available manufacturers. Manufacturers offering products that may be incorporated into the work include, but are limited to, the following:

1. Berk-Tek; a Nexans company.
2. CommScope, Inc.
3. Mohawk; a division of Belden CDT.

4. Superior Essex Inc.
  5. SYSTIMAX Solutions; a CommScope, Inc. brand.
  6. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
  7. Belden, Inc.
- B. Description: 100-ohm, 4-pair UTP, covered with a blue thermoplastic jacket.
1. Comply with ICEA S-90-661 for mechanical properties.
  2. Comply with ANSI/TIAANSI/TIA-568.2-D for performance specifications.
  3. Comply with ANSI/TIAANSI-TIA-568.2-D, Category 6
  4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
    - a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
  5. Wire Color Coding:
    - a. Orange - BAS

## 2.5 UTP CABLE HARDWARE

- A. Manufacturers Subject to compliance with the specified requirements, provide products by one of the following available manufacturers. Manufacturers offering products that may be incorporated into the work include, but are limited to, the following:
1. Berk-Tek; a Nexans company.
  2. CommScope, Inc.
  3. Mohawk; a division of Belden CDT.
  4. Superior Essex Inc.
  5. SYSTIMAX Solutions; a CommScope, Inc. brand.
  6. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
  7. Belden, Inc.
- B. General Requirements for Cable Connecting Hardware: Comply with ANSI/TIAANSI/TIA-568- D, IDC type, with modules designed for punch-down

caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

- C. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables. All patch panels shall be 48 port.
  - 1. Number of Jacks per Field: Provide one for each four-pair UTP cable indicated conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.
- D. Jacks and Jack Assemblies: Modular, color-coded, eight-position eight conductor modular receptacle units with integral IDC-type terminals.
  - 1. Comply with ANSI/TIAANSI/TIA-568.2-D, Category 6
- E. Patch Cords: Factory-made, four-pair cables in 3'-20' in length; terminated with eight-position modular plug at each end. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure specified category performance. Patch cords shall have latch guards to protect against snagging.
  - 1. TR location: Provide one (1) patch cord to match cable and Jack Assembly category rating per port on the patch panel.
  - 2. Floor outlet locations: Provide one (1) ten foot modular patch cord to match cable and Jack Assembly category rating per eight-position eight conductor modular receptacle.

## 2.6 TELECOMMUNICATIONS OUTLET/CONNECTORS

- A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with ANSI/TIAANSI/TIA-568.2-D.
- B. Workstation Outlets: Provide connector assemblies mounted in single or multigang faceplates as shown on contract drawings.
  - 1. Metal Faceplate: Stainless steel complying with requirements in Division 26 Section "Wiring Devices."
  - 2. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.
  - 3. Legend: Factory labeled by silk-screening or engraving.
  - 4. Legend: Machine printed, in the field, using adhesive-tape label.
  - 5. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

## 2.7 OPTICAL FIBER CABLE MANUFACTURERS

A. Subject to compliance with the specified requirements, provide products by one of the following available manufacturers. Manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. Superior Essex Inc.
2. CommScope, Inc.
3. Corning Cable Systems
4. General Cable Technologies Corporation
5. Belden, Inc.
6. Mohawk; a division of Belden CDT
7. Optical Cable Corporation
8. Uniprise; a CommScope, Inc. brand
9. SYSTIMAX Solutions; a CommScope Inc. brand
10. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
11. Hitachi Cable America Inc.

B. Indoor OS2 Singlemode

1. Description: 12-strand fiber, armored nonconductive, tight buffer optical fiber cable
2. Comply with ICEA S-83-596 for mechanical properties.
3. Comply with ANSI/TIA-568.3-D for performance specifications.
4. Comply with ANSI/TIA-492-CAAA for detailed specifications.
5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
  - a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262
6. Maximum Attenuation: 0.3 dB/km at 1550 nm
7. Jacket:
  - a. Jacket Color: Yellow

- b. Cable cordage jacket, fiber, unit, and group color shall comply with ANSI/TIA-598- B.
- c. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

## 2.8 OPTICAL FIBER CABLE HARDWARE

- A. Manufacturers: Subject to compliance with the specified requirements, provide products by one of the following available manufacturers. Manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
  - 1. Hubbell Premise Wiring.
  - 2. Leviton Voice & Data Division.
  - 3. Nordex/CDT; a subsidiary of Cable Design Technologies.
  - 4. Panduit Corp.
  - 5. Siemon Co. (The)
  - 6. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
  - 7. Belden, Inc.
  - 8. Ortronics Corp.
  - 9. Corning Cable Systems
  - 10. Optical Cable Corporation (OCC)
  - 11. Hellermann Tyton
- B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, simplex and duplex cable connectors
  - 1. Number of Connectors per Field: Provide one for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit the specified expansion criteria.
  - 2. Fiber optic enclosures shall be rack-mountable with accommodations for splice trays.
  - 3. Install fusion splice trays as needed for transition points and factory terminated pigtails.
  - 4. LC duplex 12-fiber coupler panels shall be used for singlemode fiber.
  - 5. Size fiber enclosure for 25% percent spare capacity.

- C. Patch Cords: Provide factory-made, dual-fiber cables in one (1) meter lengths. Supply LC duplex for one-half of the total termination points.
- D. Patch Cords: Provide factory-made, dual-fiber cables in three (3) meter lengths. Supply LC duplex for one-half of the total termination points.
- E. Cable Connecting Hardware:
  - 1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of ANSI/TIA-604-2, ANSI/TIA-604-3-A, and ANSI/TIA-604-12. Comply with ANSI/TIA-568.3-D.
  - 2. Singlemode connector type: LC
  - 3. Connectors for multimode and singlemode shall be field installed via fusion splicing.

## 2.9 EQUIPMENT FRAMES

- A. Wall mounted horizontal distribution cabinet – Tripplite #SRW10US

## 2.10 CABLE MANAGEMENT

- A. Horizontal Cable Management for Racks, Frames or Cabinets
- B. Place horizontal cable managers above and below each patch panel in each rack/cabinet. The horizontal cable manager will guide patch/equipment cords between the vertical cable manager and individual network port connections.
- C. Provide 2 RMU of horizontal cable management above and below every patch panel. Cables must be able to access the cable manager so that no ports are blocked by the cables.
- D. The manufacturer will state estimated cable fills for the cable manager in the product data sheet.
- E. The horizontal cable manager will match the rack-mount width of the racks/cabinets.
- F. The horizontal cable manager will attach to the front or rear of the rack/frame/cabinet with screws and will be sized to fit within standard EIA-310-D (1-3/4" high RMU) rack-mount spacing. The manufacturer of the horizontal cable manager will sell compatible racks/cabinets.
- G. Design Make: Tripplite SRCABLERING2U, Black or approved equal.

## 2.11 POWER STRIPS

- A. One per rack

- B. NEMA L5-20P with 10ft. cord
- C. Tripp-Lite PDUMH15-ISO or approved equal.

2.12 NETWORK SWITCH

- A. 24 Port Switch – HPE Aruba 2930F 24G 4SFP (JL259A)
- B. Single Mode SFP Module

2.13 FIRE STOP CABLE PASS-THRU SLEEVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are limited to, the following:
  - 1. Basis of design: Specified Technologies Inc.
  - 2. Approved equal by:
    - a. 3M Corporation
    - b. Hilti Corporation
    - c. Wiremold- Legrand Corporation
- B. Fire Rated Cable Pathways: STI EZ-PATH Brand device modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:
  - 1. Specified Technologies Inc. (STI) EZ-PATH Series 44 Fire Rated Pathway
  - 2. Specified Technologies Inc. (STI) EZ-PATH Series 33 Fire Rated Pathway
- C. EZ-path series 44 wall sleeves shall be provided for all telecom room penetrations to cable distribution system.
- D. Horizontal cable pathway locations greater than 20 cables fire stop sleeves shall be STI EZ-Path series 33.
- E. Horizontal cable pathway locations fewer than 20 cables EMT sleeve with UL listed system for firestopping is acceptable. Caulks and sealants shall be as manufactured by STI, 3M, Nelson, or approved equivalent.
- F. Fill ratio for fire stop EMT sleeves shall not exceed 20% fill capacity.

## 2.14 GROUNDING

- A. Comply with requirements in Division 26 Section "Grounding and Bonding" for grounding conductors and connectors.
- B. Comply with ANSI-J-STD-607-C.

## 2.15 IDENTIFICATION PRODUCTS

- A. Comply with ANSI/TIA-606-C and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

# PART 3 - EXECUTION

## 3.1 INSTALLATION OF PATHWAYS

- A. Comply with ANSI/TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
- B. Comply with requirements in Division 26 Section "Raceways and Boxes" for installation of conduits and wireways.
- C. Install manufactured conduit sweeps and long-radius elbows whenever possible.
- D. Pathway Installation in Communications Equipment Rooms:
  - 1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
  - 2. Install cable trays to route cables if conduits cannot be located in these positions.
  - 3. Secure conduits to backboard when entering room from overhead.
  - 4. Extend conduits 3 inches (76 mm) above finished floor.
  - 5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

## 3.2 NON-CONTINUOUS CABLE SUPPORTS

- A. Installation and configuration shall conform to the requirements of the current revision levels of ANSI/ TIA Standards 568 & 569, NFPA 70 (National Electrical Code), applicable local codes, and to the manufacturer's installation instructions.



- B. Do not exceed load ratings specified by manufacturer.
- C. Adjustable non-continuous support sling shall have a static load limit of 100 lbs.
- D. Follow manufacturer's recommendations for allowable fill capacity for each size non-continuous cable support.

### 3.3 WIRING METHODS

- A. Wiring Method: Install cables in raceways, J hooks, and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables accessible ceilings, walls, and floors except in unfinished spaces.
- B. Install plenum cable in environmental air spaces, including plenum ceilings.
- C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
- D. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
- E. Provide equipment frames and ladder racking as outlined in telecommunications series drawings.

### 3.4 INSTALLATION OF CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
  - 1. Comply with ANSI/TIA-568.2-D.
  - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
  - 3. Install 110-style IDC termination hardware unless otherwise indicated.
  - 4. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
  - 5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - 6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
  8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
  10. In the communications equipment room, install a 10-foot long service loop on each end of cable.
  11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- C. UTP Cable Installation:
1. Comply with ANSI/TIA-568.2-D.
  2. Do not untwist UTP cables more than 1/4 inch from the point of termination to maintain cable geometry.
  3. Terminate patch panels and outlets to a pin/pair assignment as directed by owner.
- D. UTP Patch Cords
1. Provide modular cords required to connect LAN switches to modular jacks on cross connect panel shall be furnished as part of this solicitation. Quantities should be equal to the total number of network outlets. At the Patch panel location provide patch cable lengths as needed for a neat installation utilizing vertical wire managers. At the user outlets provide 10 foot patch cables for each 8 pin modular connector
- E. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
  2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
  3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. The telecom structured cable shall be supported by it's own independent support system.

4. Plastic “zip-ties” shall not be used. Cables shall be bundled utilizing plenum rated hook and loop type cable ties.
- F. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
  2. Install cabling after the flooring system has been installed in raised floor areas.
  3. Coil cable 10 feet long not less than 12 inches in diameter below each feed point.
- G. Group connecting hardware for cables into separate logical fields.
- H. Separation from EMI Sources:
1. Comply with BICSI TDMM and ANSI/TIA-569-D for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
  2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
  3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
  4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

- a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
- 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
  - 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

### 3.5 INSTALLATION TELECOMMUNICATIONS ROOMS

- A. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- B. Bond the shield of any shielded cable to the grounding bus bar in communications rooms and spaces.

### 3.6 FIRESTOPPING

- A. General: Install through-penetration firestop systems in accordance with Performance Criteria and in accordance with the conditions of testing and classification as specified in the published design.
- B. Install EZ Path floor grid system for all Telecommunications Room floor penetrations with additional quantity as shown on contract drawings.
- C. Install EZ Path Series 44 modules for all Telecommunications Room wall penetrations with additional quantity as shown on contract drawings.
- D. Install EZ Path or EMT sleeve where horizontal cables penetrate a fire or smoke rated wall.
- E. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of firestopping products.
- F. Comply with ANSI/TIA-569-D, "Firestopping."
- G. Comply with BICSI TDMM, "Firestopping Systems" Article.
- H. Any penetrations created for the passage of telecommunications which remains vacant at the completion of the installation shall be fire stopped.

### 3.7 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with requirements in division 26 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- C. Comply with ANSI-J-STD-607-C.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

### 3.8 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with ANSI/TIA-606-C. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. For fire-resistant plywood, do not paint over manufacturer's label.
- C. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an AutoCad electronic copy of final comprehensive schedules for Project.
- D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of ANSI/TIA-606-C. Furnish AutoCad - latest version -electronic record of all drawings.
- E. Cable and Wire Identification:
  - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
  - 2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
  - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
  - 4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

- a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
  - b. Label each unit and field within distribution racks and frames.
- 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- F. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in ANSI/TIA-606-C.
  - 1. Cables use flexible vinyl or polyester that flex as cables are bent.

### 3.9 SOURCE QUALITY CONTROL

- A. Factory test UTP and optical fiber cables on reels according to ANSI/TIA-568.2-D.
- B. Factory test UTP cables according to ANSI/TIA-568.2-D.
- C. Factory test multimode optical fiber cables according to ANSI/TIA-526-14-A and ANSI/TIA- 568.2-D.
- D. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.
- E. Cable will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

### 3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Visually inspect UTP, multi-pair copper and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with ANSI/TIA-568.2-D.

2. Visually confirm cable category marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
  - a. Test instruments shall meet or exceed applicable requirements in ANSI/TIA- 568.2D. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
5. UTP Performance Tests:
  - a. Test for each outlet and MUTOA. Perform the following tests according to ANSI/TIA-568.2-D:
    - 1) Wire map.
    - 2) Length (physical vs. electrical, and length requirements).
    - 3) Insertion loss.
    - 4) Near-end crosstalk (NEXT) loss.
    - 5) Power sum near-end crosstalk (PSNEXT) loss.
    - 6) Equal-level far-end crosstalk (ELFEXT).
    - 7) Power sum equal-level far-end crosstalk (PSELFEXT).
    - 8) Return loss.
    - 9) Propagation delay.
    - 10) Delay skew.
6. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.
  - a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the

demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.

- b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.
- C. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

### 3.11 DEMONSTRATION

- A. Train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets.

### 3.12 REPAIR/RESTORATION

- A. Protect adjacent surfaces. Repair damage to any surfaces occurring as a result of the work of this section.

### 3.13 CLEANING

- A. At the completion of the system, restore aspects of the project site to its former condition. Remove daily waste and excess materials, rubbish debris, tools and equipment resulting from or used in the services provided under this contract. Remove trash from all work areas. Do not use dumpsters or trash disposal without prior approval.

END OF SECTION 271000



