



Smithsonian Institution

Office of Planning, Design & Construction

SPECIFICATIONS

PROJECT NO.: 2109103

PROJECT TITLE: QUAD REPLACE TRACK LIGHTING - 100%CD

FACILITY: INTERNATIONAL GALLERY

DATE: NOVEMBER 11, 2024

This project is approved as being in conformance with applicable provisions of the Smithsonian Directive (SD) 410.

Michael J. Carrancho, P.E., Deputy Director

Date

600 Maryland Avenue, S.W.
Suite 5001
Washington, D.C. 20024
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USPS Mail: OPDC Capital Gallery
MRC 511
P.O. Box 37012
Washington, D.C. 20013-7012

SMITHSONIAN QUAD LIGHTING AND ELECTRICAL UPGRADE

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PROJECT SUMMARY AND INFORMATION

1. PROJECT INFORMATION

- 1.1. OPDC Project No. 2109103
Quad Replace Track Lighting at the International Gallery
Quadrangle Building
1100 Jefferson Dr SW
Washington DC 20004
- 1.2. Smithsonian Institution Contacts:
Contracting Officer (CO), address for Fed Ex and UPS delivery:
Smithsonian Institution
Office of Contracting
MRC 1200
PO Box 37012, Washington, DC 20013-7012
- Contracting Officer's Technical Representative (COTR)
Smithsonian Institution
Attn: Tim Vandewalle
Office of Planning, Design, and Construction
600 Maryland Ave., SW Suite 5001
Washington, DC 20024

2 SUMMARY OF WORK

- 2.1. The Contractor shall furnish all supervision, labor, materials and equipment needed to complete the Lighting Upgrades as described in these Construction Documents at the Smithsonian Institution's International Gallery located at 1100 Jefferson Drive SW, Washington DC 20004, as set forth on the Drawings for OPDC Project No. 2109103 sheets G CS 001 through E SH 701 and in these specifications, both dated November 2024
- 2.2. The Work includes, but is not limited to:
- a. Provide New Lighting and Lighting Controls.
 - b. Remove and replace the drywall ceiling, finish and paint. Provide access panels where indicated.
 - c. Remove and replace (new/existing) ceiling elements including but not limited to Fire Alarm devices, Sprinkler heads, speakers.
 - The work includes demolishing existing fire alarm smoke detectors, strobes and combination speaker-strobes, and installing new devices in kind in existing locations as part of the entire ceiling replacement. Refer to the Drawings and Section 283111 – Addressable Fire Alarm Systems for more information.
- 2.3. Critical Elements of the Work: The successful Contractor shall be fully qualified to install critical elements of the Work. Upon request of the Contracting Officer, bidders shall submit a statement of qualifications to address the following critical elements of the Work:
- a. Drywall subcontractor for demolishing existing ceiling assembly, reinstalling a new ceiling with a level 5 finish, and has achieved similar complexities in finish level.

3 CONTRACT TIME FOR COMPLETION

3.1. Work under this contract shall begin by the Contractor within ten (10) calendar days after the Notice to Proceed and shall be completed within the total contract time of 200 calendar days. All work, including project closeout activities, shall be completed in every respect within the contract time.

3.2. The start date and completion date shall be as stated in the Notice to Proceed issued by the Contracting Officer.

4 PHASING OF THE WORK

4.1. The phasing direction for the Work is that the Work is to start on the western bay (the Asian Art side), then the central bay, and finish on the eastern bay (the African Art side).

4.1.1 The eastern bay shall be operational to the public until the middle bay is about to be completed. The National Museum of African Art will have that space active and open to the public while the western and middle bay have construction underway.

4.1.2 Fire Protection, Fire Alarm, Mechanical, and Lighting systems to remain operational during the construction of each phase.

5 SCHEDULE OF BID OPTIONS FOR BID

5.1. The following is a brief Statement of the Work identified for bid, bid options. The complete description of the Work is identified elsewhere in the drawings and specifications.

Bid Option 1: ADD

Contractor to purchase luminaire types defined in "Luminaire Schedule – Bid Option 1" (track heads), test each track head to confirm operation, then turn over to owner for storage. Testing to be performed on separate track sample with cord and plug power connection.

6 SCHEDULE OF UNIT PRICES

6.1. The unit prices in the following schedule shall be submitted as part of the bid. The Smithsonian reserves the right to accept or reject any or all unit prices.

6.2. The Contractor agrees that, in the event that the Contractor is directed by the Smithsonian to increase or decrease the quantities of work required by the contract documents on items listed below, the contract amount shall be adjusted based on the following unit prices.

6.3. Unit prices shall include the furnishing of all materials, labor, equipment and services necessary for or incidental to the execution of the work specified. Unit prices shall include all direct and indirect costs, overhead, taxes, insurance and profit.

6.4. These unit prices shall be binding upon the Contractor for the duration of the project. No escalation or other variation shall be allowed.

6.5. If requested by the Smithsonian, the Contractor shall provide material, equipment and personnel to verify or determine changes in quantities. Contractor measurements and calculations shall be subject to verification by the COTR.

6.6. Schedule of Required Unit Prices

<u>ITEM</u>	<u>Price (\$)</u>	<u>Per Unit</u>
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7 BIDDER EXAMINATION OF SITE

7.1. Every effort has been made to indicate all work necessary to complete the project as identified. All bidders shall carefully examine the premises during the bid period and satisfy themselves as to the extent, nature and location of the work, general and local conditions, particularly those bearing on transportation, disposal, handling and storage of materials, availability of labor, water, electric power, access routes, uncertainties of the weather, type of equipment and facilities needed for the successful execution of the Work.

7.2. Before the bid opening date, bidders may view the project site on an appointment basis. Any comments, information or discussion during the site visit shall not modify the contract documents. Bidders shall make an appointment to view the site by contacting:

Mr. Tim Vandewalle, Construction Manager
 Telephone No. (202) 679-7094
 Smithsonian Institution
 600 Maryland Ave SW Suite 5001
 Washington DC 20013

7.3. Pre-Bid Conference and Site Visit: Before the bid opening date, a scheduled pre-bid conference and site visit will be announced. The purpose of the scheduled meeting is to provide an opportunity for all bidders to review the project site. Any comments, information or discussion during the site visit shall not modify the contract documents.

7.4. Not used.

7.5. This project requires special arrangements for access to a non-public area. Access to the site may be restricted at times other than during the scheduled visit.

8 NON-PUBLIC, TENANT AND SECURED SPACES

8.1. Certain tenant spaces, non-public spaces, utility and equipment rooms and other areas related to or used for purposes of storage, conservation, research, curation of museum collection and artifacts or for scientific research may have restricted access.

8.2. The Contractor shall identify to the COTR as soon as possible, but no less than two (2) working days in advance, any occupied areas that the Contractor must access that are located outside the limits of the project site. The Contractor shall identify in writing:

- 8.2.1 Restricted areas to be accessed.
- 8.2.2 Specific reason for needing access
- 8.2.3 Nature of the work to be performed.
- 8.2.4 Date(s) and hours needed to complete construction work activity.

9 MUSEUM ARTIFACTS AND SCIENTIFIC RESEARCH MATERIALS

9.1. The handling of museum artifacts or scientific research experiments by the Contractor is strictly prohibited without written consent of the Smithsonian. The existing museum artifacts and research related materials may be moved only by authorized Smithsonian Museum curatorial personnel. An offender of this clause may be subject to arrest or removal from the premises and project by Smithsonian security officers.

9.2. If temporary relocation of artifacts or research experiments is necessary, the Contractor shall give notice to the COTR at least five working days in advance of the time relocation is needed.

9.3. Humidity/Temperature Controlled Spaces: The Contractor shall take care to minimize fluctuations in air conditions and quality, particularly in areas containing artifacts and storage collections and laboratories and scientific research experiments. Humidity and temperature- controlled areas require consistency of utility operation.

10 PROTECTION OF HISTORIC PROPERTIES

10.1. The project site is located in a designated National Historic Landmark property and requires special attention to the quality of materials selected for installation and workmanship efforts to satisfactorily preserve and restore historic elements and finishes of an historic landmark structure.

10.2. Upon request of the COTR, the Contractor shall submit evidence of technical competence in restoration work for National Historic Landmark structures, including subcontractor resumes, references and photographs or previous similar work.

10.3. Without exception, all original building fabric of the Sackler Gallery, the Museum of Asian Art, and the Museum of Asian Art is designated historic.

11 COMMITMENT TO SUSTAINABILITY

11.1. The Smithsonian Institution is a trust instrumentality of the United States and although not an Executive Branch of the U.S. Government, is committed to planning, designing, constructing, maintaining and operating its owned and leased buildings and facilities consistent with Federal environmental and energy management requirements, as listed in the Smithsonian OPDC Codes, Standards and Guidelines document, dated October 2021, with rolling chapter revisions through 2023–2025, to the maximum extent practical.

CONTRACTOR USE OF PREMISES

12 HOURS OF WORK, WORKDAYS AND GOVERNMENT HOLIDAYS

12.1. Work shall be performed under this contract during the normal workdays of Monday through Friday, except Smithsonian holidays as specified herein and the normal work hours of 6:00 AM to 3:30 PM

12.2. The International Gallery will be partially occupied for a short duration, requiring the work, under this contract, to be performed in phases as described in Section 3.0. The normal workdays and hours of the building occupants are Monday through Friday between 6:00AM and 3:30PM. Therefore, the Contractor shall perform work under this contract during the normal workdays of Monday through Friday and the normal work hours of 6:00AM through 3:30PM

12.3. For each occasion the Contractor intends to work on Saturdays, Sundays or Smithsonian holidays or during hours other than those indicated above, the Contractor shall obtain written permission from the COTR, at least three (3) working days in advance.

12.4. The Contractor shall reimburse the Smithsonian Institution for security and inspection services provided by the Smithsonian when the Contractor chooses to work outside the normal workdays and hours, as identified herein. However, the Contractor will not be charged for SI overtime security and inspection services, if, in the opinion of the COTR, the work cannot be done during the normal workdays and hours due to requirements of the Smithsonian.

12.5. Smithsonian Holidays: For holidays that fall on Saturday, the Smithsonian holiday is observed on the previous Friday. For holidays that fall on Sunday, the Smithsonian holiday is observed on the following Monday. The Smithsonian holidays are listed below.

New Year's Day	January 1
Martin Luther King Jr.'s Birthday	January, third Monday
George Washington's Birthday	February, third Monday
Memorial Day	May, last Monday
Juneteenth	June 19th
Independence Day	July 4
Labor Day	September, first Monday
Columbus Day	October, second Monday
Veterans' Day	November 11
Thanksgiving Day	November, fourth Thursday
Christmas Day	December 25
President's Inauguration Day	January 20

13 QUALITY CONTROL

13.1. The Contractor shall provide for quality control, inspections, testing and re-testing as necessary for all work, including that of subcontractors, to assure compliance with the contract documents.

13.2. Contractor Quality Control (CQC) System: The Contractor shall provide a quality control organization and system to perform quality control, inspections, testing and re-testing as necessary for any item of work, including that of Subcontractors, to assure compliance with the contract documents. The Superintendent can perform and serve as the quality control representative.

13.3. CQC Plan Requirements: The Contractor shall submit for review/approval a CQC Plan within thirty (30) calendar days after Contract Award to the COTR for approval. The Plan shall detail the procedures, instruction and reports to be used to assure compliance with the contract documents. As a minimum, the Plan shall include the following:

13.3.1 Designation of the CQC Representative: Identify the person and list duties, responsibilities and authority. The Superintendent can perform and serve as the quality control representative.

13.3.2 Organization Chart: Show CQC staff and its relationship with other staff members and Subcontractors.

13.3.3 Personnel Matrix: For each specification section, identify who is the authorized submittal reviewer, who will inspect the work, what testing laboratory or person will perform on-site testing, who will perform factory inspections and testing and who will certify the documentation

13.3.4 Responsibility and Authority: State the responsibility and authority for each individual in the CQC system.

13.3.5 Personnel Qualifications: Provide resumes and descriptions of prior experience on similar work.

13.3.6 Inspection Procedures and Schedule: Identify the inspection and testing procedures and scheduled dates as reflected on the CPM project schedule, organized by technical specification section.

13.3.7 Submittal Review Procedures and Schedule: Provide submittal log in accordance with the Submissions section. For each specification section, identify the name(s) of person(s) authorized to review and sign submittals for compliance.

13.3.8 CQC Documentation: Identify the procedures for documenting quality control operations, inspection and testing. Provide samples of each type of required documentation - all forms, logs, reports, etc. Include a testing log listing all tests and inspections required by the contract documents and stating the action to be taken by the Contractor and/or the Smithsonian.

13.4 CQC Staffing Requirements: The following listing of minimum staff requirements in no way relieves the Contractor of meeting the basic requirements of the Contractor Quality Control System for this project. The Contractor shall ensure an adequate staff to meet the CQC requirements at all times during construction. When necessary for a proper CQC organization, the Contractor shall provide additional staff at no cost to the Smithsonian.

14 PERMITS, LICENSES & FEES

14.1. The Contractor shall obtain and pay for all applicable permits and licenses required by regulating agencies, including, but not limited to: permits for pedestrian and road markings, construction fences, sidewalk cuts, utility company connections, elevator certificates, waste containers, etc.

15 UTILITY SERVICE INTERRUPTIONS AND NEW CONNECTIONS

15.1. Any planned interruption in utility service must be approved by and coordinated through the COTR. The Contractor shall submit a written request as far in advance of scheduled interruption as possible, but no less than two (2) full working days in advance. The Contractor shall make the necessary temporary provisions to supply continuous electrical power, HVAC space conditioning and security as required during periods when service is interrupted. Utility shutdown cannot be scheduled during the workday between 6:00 AM – 6:00 PM or during scheduled events.

- The Contractor's work efforts to restore service shall be continuous until the interrupted utility is back in service.
- A fire watch shall be provided for the time periods when fire suppression and detection systems are out of service.
- During the course of the Work, all existing smoke and heat detectors and sprinklers heads must remain operable. Coverings may be applied to protect them from spray coatings or other hazardous conditions only during the actual operations. Coverings must be removed immediately after the operations have concluded, but at the end of each working day at a minimum. When work produces dust or other airborne contaminants, e.g. spray painting, that could impair existing fire suppression or detection system(s) or when the system itself is otherwise impaired (drained down, etc.), the Contractor shall obtain a daily FIRE SYSTEM IMPAIRMENT PERMIT. Fire System Impairment Permit must be obtained a minimum of 48 hours in advance. Reference attached Fire System Impairment Permit form and General Instructions.

16 PROTECTION OF THE SITE

16.1. The Contractor shall provide adequate protection for all parts of the building, including interior and exterior surfaces, its occupants and contents and grounds wherever work under this contract is performed.

16 DEBRIS CONTROL AND DAILY CLEANUP

16.1. The Contractor shall regularly clean up the work areas and shall, at all times, maintain the project in as neat and orderly a manner as is consistent with normal operations. Debris resulting from construction operations shall be removed daily from the site by the Contractor. The Contractor shall keep all access, haul routes and site areas free of dirt, debris and other materials resulting from construction activities.

16.2. The Contractor shall recycle, salvage or otherwise divert from landfills and incinerators, at least 50%, with a goal of at least 75%, by weight (tons), unless otherwise noted, of non-hazardous

construction and demolition material. The contractor shall track recycling efforts and diversion rates using the Construction and Demolition Waste Tracking Sheet, attached. Before any work is started, the contractor shall submit a Construction Waste Management Plan, consisting of waste identification and a waste reduction work plan. Waste identification shall indicate anticipated types and quantities of demolition, site-clearing, and construction waste generated by the Work. Include estimated quantities and assumptions for estimates. Waste reduction work plan shall 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. With each application for payment, the contractor shall submit the Construction and Demolition Waste Tracking Sheet, attached, with data compiled for the payment period, including receipts from hauler or destination. Before request for substantial completion, the contractor shall submit calculated end-of-Project percentage of waste diverted from landfills and incinerators (recycled, salvaged, or disposed) as a percentage of total waste generated by the Work. With request for final payment, the contractor shall submit actual percentage of waste diverted from landfills and incinerators (recycled, salvaged, or disposed) as a percentage of total waste generated by the Work.

17 STAGING, STORAGE AND WORK AREAS

17.1. The Contractor shall provide adequate storage and protection of materials and equipment delivered to the site to prevent theft, weather damage, mold infiltration, moisture damage and other physical damage.

18 BONDING AND INSURANCE

18.1. Bonding: In accordance with IDIQ Contract requirements.

18.2. Insurance: In accordance with IDIQ Contract requirements.

SUBMISSIONS

19 SUBMITTALS AND REVIEWS

19.1. Contractor Responsibility for Submittals: The Contractor shall provide all required submittals, by technical specification section, in accordance with the contract documents. All submittals, with exception of mockups or samples, are to be submitted electronically by email in PDF format. The Contractor shall clearly indicate on the submittal that it has been reviewed by the Contractor and found to meet the project requirements. Any items submitted as substitutions shall be clearly identified as such on the submittal and the transmittal document. If shop drawings show variations from the contract documents because of standard shop practices or for other reasons, the Contractor shall provide a separate, written description of variations along with the submittal. The Contractor shall:

19.1.1. Review each submittal for conformance with requirements of the contract documents and coordination with related work.

19.1.2. Determine and verify all field measurements, required material quantities, method of assembly or erection, installation requirements and proper connection to adjoining materials installed by others.

19.1.3. Assure that all submittals use the appropriate units of measure. All drawings and technical data shall be in SI (metric) units for projects designed in SI units. Preprinted literature in other units shall be accompanied by documentation to show conformance to project requirements.

19.1.4. Transmit all required submittals for a technical specification section at the same time unless prior written waiver of this requirement has been provided by the COTR.

19.1.5. Transmit submittals to the COTR in a logical and orderly sequence in accordance with the Submittal Schedule to prevent project delays or adversely impact work by the Smithsonian Institution or other contractors.

19.1.6. Correct and resubmit submittals according to response from the Smithsonian Office of Planning, Design, and Construction.

19.1.7. Commence work on items requiring submittals only after all related submittals are reviewed and approved by the Smithsonian. All Work shall conform to approved submittals.

20 TOXIC AND HAZARDOUS SUBSTANCES

20.1. The Contractor shall submit to the COTR for approval, at least ten (10) working days prior to their intended use, a written list of toxic and hazardous substances that will be used on the project. The Contractor shall submit a "Safety Data Sheet" for these substances to identify the following information:

- 20.1.1. Product Identification
- 20.1.2. Hazardous Ingredients
- 20.1.3. Composition/Information on Ingredients
- 20.1.4. First Aid Measure
- 20.1.5. Fire-Fighting Measures
- 20.1.6. Accidental Release Measures
- 20.1.7. Handling and Storage
- 20.1.8. Exposure Controls / Personal Protection
- 20.1.9. Physical and Chemical Properties
- 20.1.10. Stability and Reactivity
- 20.1.11. Toxicology Information
- 20.1.12. Ecological Information (Non-Mandatory)
- 20.1.13. Disposal Considerations (Non-Mandatory)
- 20.1.14. Transport Information (Non-Mandatory)
- 20.1.15. Regulatory Information (Non-Mandatory)
- 20.1.16. Other Information

20.2. The Contractor will commit to not using the following toxic and hazardous materials:

- 20.2.1. Products containing asbestos, urea formaldehyde, polychlorinated biphenyls (PCBs) and/or chlorinated fluorocarbons.
- 20.2.2. Products containing lead content, including solder or flux containing more than 0.2% lead; domestic water pipe or pipe fittings containing more than 8% lead; and paint containing more than 0.06% lead.
- 20.2.3. Chlorofluorocarbon (CFC)-based refrigerants in new base building heating, ventilating, air conditioning and refrigeration (HVAC&R) systems and comprehensive CFC phase-outs when reusing existing base building HVAC equipment.
- 20.2.4. The Contractor hereby understands that historic properties may contain pre-existing harmful materials and coatings including, but not limited to, arsenic, lead, dioxide, polyvinylchloride (PVC) and asbestos. Upon discovery of hazardous or toxic materials, the Contractor shall alert the COTR immediately.

21 EXISTING FIRE PROTECTION SYSTEMS

21.1. During the course of the Work, all existing smoke and heat detectors and sprinkler heads

must remain operable. Coverings may be applied to protect them from spray coatings or other hazardous conditions only during the actual operations. Coverings must be removed immediately after the operations have concluded. Damaged detectors and sprinkler heads shall be replaced immediately by the Contractor at no additional cost to the Smithsonian Institution. The Contractor shall test replaced detectors and sprinklers after installation to the satisfaction of the COTR.

21.2. If a fire protection or life safety system must be impaired for modifications or adjustments during the project, the Contractor shall obtain a daily "Fire System Impairment Permit." Each permit must be obtained at least two (2) working days in advance from the Building Managers Office and be posted at the jobsite prior to beginning the scheduled work.

22 GENERAL SECURITY REQUIREMENTS

22.1. The Contractor and his employees must comply with security requirements imposed by the Smithsonian Institution, including any necessary security clearances. Failure to inspect the site or obtain knowledge of security regulations shall not relieve the Contractor from security requirements or from performance of any part of the work.

23 JOBSITE SAFETY

23.1. Safety Coordinator: The Contractor shall designate a person responsible and accountable for personnel safety at both corporate and project level at the project site for the duration of the project. Contracts specifically requiring safety or industrial hygiene personnel shall include a copy of their resumes. Qualifications for the Safety Coordinator shall include the OSHA 30-hour course or equivalent course.

23.2. Occupational Safety and Health: This contract is subject to Title 29 of the Code of Federal Regulations, Part 1910 "Occupational Safety and Health Standards" and Part 1926 "Safety and Health Regulations for Construction" pursuant to the Occupational Safety and Health Act (OSHA) of 1970 administered by the US Department of Labor, Occupational Safety and Health Administration.

23.3. Report of Accident or Illness: In the event of any accident or illness for which medical assistance is required, any criminal action, or any fire, the Contractor shall notify the appropriate authority (ambulance, police, fire Dept.), Smithsonian Security, and the COTR.

23.4. Contractor Personnel to be contacted: The Contractor shall submit a written list of emergency telephone numbers and names of persons to contact for the General Contractor superintendent and for each major sub-contractor working on the project site. The initial list shall be submitted to the COTR at the Preconstruction Meeting. The list shall be updated and resubmitted to the COTR as needed.

23.5. Site Specific Safety Plan: Upon award of this contract, the contractor shall provide a Site Specific Safety Plan (SSSP). The SSSP is a safety and health policy and program document and outlines how the contractor will safely conduct their work. This plan shall be job-specific and shall also address any unusual or unique aspects of the project or activity for which it is written. The SSSP shall interface with the employer's overall safety and health program, and a copy shall be available on the work site. Any portions of the employer's overall safety and health program that is referenced in the SSSP shall be included as appropriate. The plan shall include but not limited to the following:

- a) Signature Sheet that must include plan concurrence (e.g., Chief of Operations, Corporate Chief of Safety, Corporate Industrial Hygienist, project manager or superintendent, project safety professional, project QC). Provide concurrence of other applicable corporate and project personnel (Contractor).
- b) Background Information that must include Brief project description, description of work to be performed, and location; phases of work anticipated these will require a Job Hazard Analysis (JHA's). OSHA 3071

- c) Statement of Safety and Health Policy
- d) Responsibilities and lines of Authority
- e) Subcontractors and Suppliers
- f) Training
- g) Safety and Health inspections that include assignment of responsibilities for a minimum daily/weekly job site safety and health inspection during periods of work activity level of technical proficiency needed to perform the inspections, proof of inspector's training/ qualifications
- h) Accident Reporting
- i) Plans (programs, procedures) required by the Safety Manual. Based on a risk assessment of contracted activities and on mandatory OSHA compliance programs, the Contractor shall address all applicable occupational risks and compliance plans. Using the 29 CFR 1926 and/or current and accepted procedures in the EM 385-1-1 as a guide
- j) Risk Management Processes Detailed project-specific hazards and controls shall be provided by a Job Hazard Analysis for each major phase/activity of work, including but not limited to work involving confined space, fall protection, trenching/excavation, crane/rigging, steel erection, hot work, protection of the public, scaffolding, and other activities that involve high risk potential.

25 SCHEDULING & PAYMENTS / BAR CHART

25.1. Project Schedule: The Contractor shall submit, to the COTR for approval, a Gantt bar chart project schedule within 14 calendar days after the date of contract award. Submit in PDF format. No work shall start at the site until the project schedule has been approved by the COTR. The approved bar chart will represent a baseline schedule on which the monthly construction progress will be indicated and submitted to the COTR. The baseline project schedule shall comply with the following:

25.1.1. Weekly breakdown of work activities shall be provided, including interaction between building trades, subdivided by items of work and areas of the project. Items of work shall be grouped and subdivided according to the divisions of the Construction Specifications Institute (CSI) format.

25.1.2. The start date and completion date shall be consistent with the Contract Time established by the Contracting Officer. Any intermediate deadline dates needed to meet specific requirements for Smithsonian use of portions of the work shall be shown.

25.1.3. Project condition survey activities shall be scheduled not later than the 14th calendar day of the contract time and prior to the start of any site work.

25.1.4. Project closeout activities shall be scheduled for completion in accordance with the requirements for the Contract Time for Completion.

25.1.5. Order dates and projected delivery dates shall be shown for equipment, special devices, hardware, products or other items requiring long lead time.

25.1.6. Required delivery dates for items to be furnished by Smithsonian and installed by the Contractor shall be shown, as well as items to be furnished and installed by Smithsonian, which will affect the Contractor's work.

25.1.7. Review periods for all submittals and time required for all necessary inspection and/or testing shall be shown.

25.1.8. Dates shall be given for ordering, delivery, installation and testing of major equipment and special materials and equipment.

25.1.9. The Contractor shall specifically identify work activities and dates

25.2. Revisions to Baseline Schedules: The Contractor shall submit, to the COTR for approval, all revisions to the approved baseline project schedule. The Contractor shall submit a proposed revision to the schedule, as necessary, along with proposals for construction changes, clearly indicating modifications to the schedule based on the proposal. The Contractor shall also submit, for review and approval, any proposed changes to the schedule due to inability to accomplish the work as planned for any reason. Approved changes to the schedule shall be incorporated into the Project Schedule and it shall be resubmitted as necessary or as requested by the COTR.

25.3. Progress Behind Schedule: If it becomes apparent to the COTR that the overall progress of the project is behind the approved project schedule, then the COTR will notify the Contractor in writing. The Contractor shall submit, to the COTR for approval, a Recovery Schedule and Plan to describe how the Work will be accelerated to meet the Contract Time requirements in accordance with the General Conditions contract clause entitled "Commencement, Prosecution and Completion of the Work." The Recovery Schedule shall be superimposed on the approved baseline project schedule to demonstrate that proposed recovery activities will accomplish completion of the work by the approved completion date.

25.4. Reporting Progress and Applying for Payment: Each month, the Contractor shall apply for payment and submit a report of the actual construction progress as follows:

25.4.1. By the 25th of each month, the Contractor and the COTR shall have inspected the work to determine percentages complete for each item, projected through the end of the month. The parties shall attempt to reach agreement on each item, but if they cannot reach an agreement the COTR will determine percent complete.

25.4.2. By the last day of the month, the Contractor shall submit an Application for Payment based on the determined percentages complete for each item. The application shall be submitted electronically on the Smithsonian standard Application for Payment form. Each copy of the Application for Payment shall be accompanied by the following:

- A Progress Schedule identifying the cumulative progress superimposed on the latest revision of the approved Project Schedule. The net progress for the month and applicable dates shall be clearly indicated.
- A complete set of copies of certified weekly-payroll data for the period.
- A complete set of monthly progress photos. At least 24 color progress photographs shall be provided. The actual number and location of views shall be directed by the COTR. Photographs shall be taken at the start and finish of various elements of construction designated by the COTR. Additional photographs showing any work that will be concealed after inspection shall be submitted. Each photograph will be marked with this information box:

Smithsonian Institution

Title: _____

OFEQ Project No.: _____ Contract No.: _____

Contractor: _____

Photo No.: _____ Date: _____ Time: _____

Description/View: _____

- A completed monthly waste diversion report.

- An update to date change order log

25.5. Response to Application:

25.5.1. Payment shall be made only for progress agreed upon by the COTR, performed on original Contract Work or approved modifications. Failure to submit the Application in accordance with the specifications will prevent the processing of payments.

25.5.2. Any changes of address must be signed by the Contractor's authorized person and submitted to the Contracting Officer.

26 Warranty of Construction

25.1. The Contractor shall warrant that the work performed under this contract conforms to the contract requirements and is free of any defect in equipment, materials, design furnishes or workmanship performed by the Contractor or any subcontractor or supplier at any tier. Unless otherwise stated in the technical sections of the Specifications, the warranty of the Work shall continue for a period of one (1) year from the date of Final Completion status. If Smithsonian takes partial occupancy before Final Completion, then the warranty for that portion shall be in effect for a period of one (1) year beginning on the date of Substantial Completion for that portion of the Work.

25.2. Submission of original warranties for all products, equipment and systems:

The Contractor shall assemble original warranty certificates or notarized copies of warranty certificates executed by the Contractor, subcontractors, suppliers and manufacturers in a tab-indexed three-ring loose-leaf binder with a durable plastic cover. The table of contents shall identify the item covered, the location of the item, the date of Substantial Completion, expiration date of the warranty and the supplier, vendor and installing contractor. Duplicate notarized copies of warranties shall be provided as required by "Manuals for Operation, Maintenance and As-Built Product Data." Include electronic copy in PDF format.

As-Built Record Drawings

26.1. During the progress of the work, the Contractor shall maintain a complete and up-to-date set of record prints, open to inspection by the COTR at any time. These prints shall provide a complete and accurate as-built record of all changes to the Contract Drawings, including rerouting of runs, relocation of items or control points and all other modifications. The exact location of pipes, conduit or other features concealed underground, under concrete, in chases or above ceilings shall be shown by perpendicular dimensions from at least two available landmarks. As-built drawings shall be neatly marked with colored pencils or ink, marked "As-Built" and signed and dated by the Contractor. Upon completion of the Work and before final payment, the Contractor shall submit, to the COTR, photographically produced as-built record drawings in digital format via file transfer or a COTR approved storage medium. The Contractor shall submit electronic files in .DWG and PDF formats.

26.2. As-Built Record Survey of Underground Utilities submitted. If outside or underground utilities are part of the work, the Contractor shall furnish, to the COTR for approval, an acceptable and accurately dimensioned survey showing location and elevation of underground storage tanks, all utility lines for water, gas, electrical, sewer, steam, etc., including valves, connections and changes in direction, as installed under the contract, within the property lines and outside the building walls. Points where utility lines emerge from the building shall be located from lot monuments. The survey shall be made to scale and must be marked "As-Built" and signed and dated by the Contractor. The Contractor shall furnish as scanned, digital copy to the COTR.

26.3. As-Built Record Specifications submitted. The Contractor shall submit a digital

(scanned) set of project specifications with annotations to identify any changes made during construction, referencing modification numbers, dates and originators of authorizing letters or memos and other sources of changes. The cover shall be marked "As-Built" and signed and dated by the COTR.

Construction and Demolition Waste Tracking Sheet:

To be submitted with each application for payment for the payment period, and at project completion with total waste data and total percentage of waste diverted from landfill for entire project period.

Project Name: _____

Start Date: _____

End Date: _____

Material Description	Disposal date	Diverted from Landfill or incinerator? (Y/N)	Diversion method (Recycled, Salvaged, etc.)	Hauler or Destination (submit receipts)	Volume (in cubic feet)	Weight (in tons)
Land Clearing Debris						
Gypsum Wallboard Scrap						
Cardboard						
Paper goods						
Beverage containers						
Assorted Plastic						
Wood Pallets						
Asphaltic Concrete Paving						
Concrete						
Brick						
CMU						
Lumber						
Plywood and OSB						
Wood Paneling						
Wood Trim						
Miscellaneous Metals						
Structural Steel						
Rough Hardware						
Insulation						
Roofing						
Doors and Frames						
Door Hardware						
Windows						
Non-Window Glass						
Glazing						
Acoustical Tile						
Carpet						

Material Description	Disposal date	Diverted from Landfill or incinerator? (Y/N)	Diversion method (Recycled, Salvaged, etc.)	Hauler or Destination (submit receipts)	Volume (in cubic feet)	Weight (in tons)
Carpet Pad						
Demountable Partitions						
Equipment						
Cabinets						
Plumbing Fixtures						
Piping						
Piping Supports and Hangers						
Valves						
Sprinklers						
Mechanical Equipment						
Electrical Conduit						
Copper Wiring						
Light Fixtures						
Lamps						
Lighting Ballasts						
Electrical Devices						
Switchgear and Panelboards						
Transformers						
Other:						
Other:						
Other:						
Total Diverted						
Total Not Diverted						
Total All Waste = Total Diverted + Total Not Diverted						
% Diversion Rate* = Total Diverted/Total All Waste						

**Percentage Diversion Rate to be compiled after project completion. Minimum Diversion rate is 50%. Goal Diversion rate is 75%*

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. Demolition and removal of selected portions of interior of building elements.
2. Removal and salvage of existing items for delivery to Owner and removal of existing items for reinstallation.

1.2 DEFINITIONS

- 1.3 Remove: Detach items from existing construction and legally dispose of off-site unless indicated to be removed and salvaged or removed and reinstalled.
- 1.4 Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver as directed by COTR.
- 1.5 Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage; prepare for reuse; and reinstall where indicated.
- 1.6 Existing to Remain: Existing items of construction that are not to be removed.

1.7 MATERIALS OWNERSHIP

- 1.8 Unless otherwise indicated, demolition waste becomes property of Contractor.
- 1.9 Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to SI that may be uncovered during demolition remain the property of SI.
- 1.10 Carefully salvage in a manner to prevent damage and promptly return as directed by the COTR.

1.11 COORDINATION

- 1.12 Arrange selective demolition schedule so as not to interfere with SI's operations.

1.13 PREINSTALLATION MEETINGS

A. Pre-demolition Conference: Conduct conference at Project Site.

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 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 require protection.
6. Review and finalize protection requirements.
7. Review procedures for noise control and dust control
8. Review storage, protection, and accounting for items to be removed for salvage or reinstallation.

1.14 INFORMATIONAL SUBMITTALS

- A. Survey of Existing Conditions: Submit survey.
- B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property for dust control and for noise control. Indicate proposed locations and construction of barriers.
- C. Schedule of Selective Demolition Activities: Indicate the following:
 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
 2. Temporary 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 continuing occupancy of portions of existing building and of partial occupancy of completed Work.
 6. Construction Barriers
 - a. All dust barriers will be constructed of non-combustible or fire-retardant materials.
 - b. Partitions will be full height, extending through suspended ceilings to the floor slab or roof deck above and will be one hour fire rated, unless sprinklers are installed and are operational on both sides of the temporary partition whereupon the partition may be permitted to terminate at the ceiling in accordance with NFPA 241.
- D. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.15 CLOSEOUT SUBMITTALS

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

1.16 FIELD CONDITIONS

- A. Conduct selective demolition so that adjacent operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by SI as far as practical.
- C. Notify COTR of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials:
 1. It is not expected that hazardous materials will be encountered in the Work.
 - a. If materials suspected of containing hazardous materials are encountered, do not disturb;

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

1.17 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding.
- B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

SECTION 01 3250**BUILDING INFORMATION MODELING (BIM) REQUIREMENTS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for Building Information Modeling including, but not limited to, the following:
1. Development of BIM Execution Plan.
 2. Development of Construction Model(s).
 3. Development of Fabrication/Shop Drawings at Contractor's option.
 4. Development of Coordination Model(s).
 5. Development of Coordination Report.
 6. As-Built Model(s) and Drawings.
- B. Related Requirements:
1. Division 01 section Operation and Maintenance Data for Facility Asset Data Requirements.
- C. Contractor's Responsibility:
1. Develop deliverables required in this Section.
 2. Contractor is solely responsible for the quality and accuracy of all documentation and submittals of this Section.
 3. The intent of BIM deliverables is to avoid interference and conflicts, optimize construction sequencing, achieve greater efficiencies in cost estimating and project coordination, and ensure access for maintenance, replacement, or repairs.
 - a. Coordination: Contractor is solely responsible for the coordination of facility systems and equipment.
 - b. Construction sequencing: Contractor is solely responsible to sequence construction activities to facilitate the fabrication and installation of systems and equipment without interference, conflicts, or delays in construction, and providing adequate access to effectively maintain and replace systems and equipment.
- D. Existing Documents: The following building information, obtained and developed by the Architect and/or Engineer during the design phase, may be available to the Contractor:
1. Design Intent Model(s) (.rvt, .ifc, & .nws / .nwd)
 2. Contract Documents (.pdf)
 3. CAD Files (.dwg)
 4. Point Clouds (.rcs)
 5. Scans of the original building design drawings (.pdf)
 6. BIM PxP (.docx, .pdf)
 7. LOD Matrix(.xlsx, .pdf)
- E. SI BIM Practice Requirements:
1. The following documents related to are available on the Smithsonian Facilities A/E Center website, under the Codes and Standards section and are applicable to BIM requirements:
 - a. Smithsonian Facilities BIM Guidelines: Describes information, procedures, and responsibilities relevant to BIM work completed by architecture, engineering and construction (AEC) consultants in order to assure accurate and consistent deliverables.

- b. SF Revit Templates: BIM templates developed by Smithsonian Facilities are available for the Contractor to use when utilizing Autodesk Revit as the model authoring software to populate with accurate project-specific facility asset data.
 - 1) Scope of required facility data is described in the template and should be modified to reflect actual Project requirements.
- c. SF Revit Template Users Guide: This document, prepared by Smithsonian Facilities, describes how to incorporate and “SF Revit Templates” and develop the project BIM.
- d. SF BIM Project Execution Plan (PxP): Template document that defines the expected BIM deliverables and guides the coordination of the project team, throughout the project lifecycle.

1.2 DEFINITIONS

- A. As-Built Model: Building Information Model(s) developed by the Contractor that represents the installed condition of facility elements.
- B. Building Information Model (BIM): A digital representation of physical and functional characteristics of a facility.
- C. BIM Project Execution Plan (PxP): A document prepared by the contractor, utilizing a standard SF PxP template that defines the expected BIM deliverables and guides the coordination of the project team, throughout the project lifecycle.
- D. Construction Model: Building Information Model(s) that demonstrates and communicates the facility data necessary to procure, fabricate, schedule or construct the Project.
- E. Coordination: A process implemented to ensure the efficiency and harmony of the relationship of facility elements. Typically performed in a BIM environment by evaluating interferences, also called “clash detection”.
- F. Coordination Model: Building Information Model(s) that demonstrates and communicates the spatial relationship of facility elements.
- G. Coordination Report: A report developed to communicate and demonstrate that the facility elements have been properly coordinated and identify areas where issues may still exist.
- H. Design Intent Model: Building Information Model(s) that demonstrates and communicates the creative objectives of the designer.
- I. Fabrication/Shop Drawing: Drawing generated by the contractor from a Construction Model based on the contract documents that communicates the information necessary to fabricate facility elements. Fabrication/Shop Drawings typically contain one system and are intended for use of trade personnel to fabricate, assemble, and install facility elements.
- J. Facility Breakdown Structure: a system-oriented hierarchical decomposition of a facility into smaller components. Typically, the facility breakdown structure is based on disciplines, trades, described by Master Format.
- K. Facility Asset Data: Non-graphical information attached to an object in a Building Information Model that defines various characteristics of an object.
- L. Furnishings: Built-in or movable cabinets, casework, seating, or other appurtenances provided

by the Contractor.

- M. Interference: Spatial conflict between facility elements.
- N. Level of Development: Describes the minimum dimensional, spatial, quantitative, qualitative, and other data includes in a model element as defined in the SF BIM Guidelines.
- O. Level of Accuracy: Describes the minimum dimensional accuracy of element(s) as defined in the SF BIM Guidelines.
- P. Conformed Model – Updates the Design Intent Model for those aspects maintained by the designer to record authorized design changes during construction.

1.3 SUBMITTALS

- A. BIM Project Execution Plan (PxP): Prepare and submit a plan utilizing the “SF BIM Execution Plan” framework document available on the Smithsonian Facilities Architectural-Engineer Information Center website. Submit the PxP in Portable Document Format (PDF) within 60 days after contract award. BIM Project Execution Plan (PxP) shall be updated as required and submitted with Final As-Built Model(s).
- B. Submit plans, sections, and other review documents monthly, in .pdf format. To include field changes that affect the accuracy of the Construction and As-Built Models.
- C. Construction Model(s): Prepare and submit, on a quarterly basis, Construction Model(s) that contain spaces, objects and data required to purchase, fabricate, and install project elements. Graphically indicate construction progress in Construction Model(s). Construction Model(s) are to be submitted with all Coordination Model(s) link into one central model using Autodesk Navisworks with all disciplines.
- D. Coordination Model(s): Prepare and submit Coordination Model(s) on a monthly basis. Coordination Model(s) are to be based on the facility breakdown structure of the Design Intent Model. Contractors are to perform all work utilizing 3D modeling software in order to facilitate seamless coordination with BIM workflows and file integration. All design elements should be produced three-dimensionally in programs that can output file formats supported by Autodesk Navisworks. Coordination Model(s) are to be submitted using Autodesk Navisworks with all disciplines.
 - 1. Coordination Model(s) are to be submitted prior to fabrication, and installation of any element within the area represented within the Coordination Model(s).
 - 2. Fabrication/Shop Drawings and Construction Model(s) are to be integrated into the Coordination Model(s) or otherwise referenced in the Coordination Model(s).
- E. CAD Drawings. Export CAD documents from the BIM authoring application in a format conforming to SI requirements. Reference the “SF Revit Template Users Guide” and “SF CAD Guidelines”.
- F. Coordination Report: Prepare and submit a written Coordination Report generated from the Coordination Model(s) prior to fabrication, and installation of any facility element within the area represented within the Coordination Model(s).
 - 1. Coordination Report is to be submitted in Portable Document Format (PDF).
- G. Final As-Built Model(s): After installation of all Facility Elements, update and submit As-Built Model(s) to document the condition of the facility upon completion of construction. As-Built

Models are to be submitted with all Model(s) and link into one central model using Autodesk Navisworks with all disciplines.

- H. As-Built Fabrication/Shop Drawings: After installation of all Facility Elements, update and submit Fabrication/Shop Drawings to document the condition of the facility upon completion of construction.
- I. By submitting the As-Built Model(s) and Coordination Report(s), the Contractor confirms that the following have been accomplished:
 - 1. Existing and As-Built conditions have been adequately identified, documented, and field verified.
 - 2. Facility elements are properly represented within the Model(s) to align with field verified conditions.
 - 3. Access to maintain, repair, or replace facility elements has been identified and validated.
 - 4. Clearances, such as those required by code and equipment specifications, have been identified and validated.
 - 5. Interferences have been identified and resolved.
- J. Data Capture (Laser Scan): Survey, prepare and submit Point Cloud files at key stages during the construction process including but not limited to, open trenches, rough-in / close-in, project completion, etc. as directed by COTR. This survey to be utilized to ensure all As-Built conditions for the project are documented properly. This will include establishing the necessary Survey Control Network throughout the site and scanning as many points as may be required to create a reliable point cloud of all interior and exterior surfaces of the building. The required object surface density of scanning shall be a minimum of 6mm (1/4"). RGB color shall be mapped to both the exterior and interior scans. Point Cloud data should be broken into separate data sets as directed by COTR and be registered in the same coordinate frame (origin point) as the As-Built Model(s). Point cloud data to be submitted using Autodesk Recap.

PART 2 - EXECUTION

2.1 CONTRACT DOCUMENTS AND DESIGN INTENT MODEL(S)

- A. The Contract Documents and Design Intent Model(s) will be provided to the Contractor for reference in the development of the Construction and Coordination Model(s) and Fabrication/Shop drawings. The Contract Documents and Design Intent Model(s) communicate creative objectives of the Architect and/or Engineer, and are not intended to be used for fabrication and construction of the facility in that the size, arrangement, and level of development of facility elements may not have the necessary tolerances to allow for fabrication.
- B. The Contract Documents are the binding document(s) of record, the Design Intent Model(s) are provided for reference only.

2.2 DEVELOPMENT OF BUILDING INFORMATION MODELING PLAN (BIM PxP)

- A. The BIM PxP shall be approved by SI prior to development of Construction / Coordination Model(s), and development of Facility Asset Data. Information contained in the BIM PxP shall conform to the "SF BIM Guidelines".

2.3 INSPECTION OF EXISTING CONDITIONS

- A. Prior to the development of the Construction / Coordination Model(s), inspect and verify

accuracy of information communicated in the Contract Documents and Design Intent Model with respect to the existing conditions. Notify Architect if any conflicts among Contract Documents, the Design Intent Model, and existing conditions are discovered. Do not proceed with development of Construction / Coordination Model(s) until conflicts are resolved to the satisfaction of SI.

2.4 FACILITY ASSET DATA

- A. See spec 01 section OPERATION AND MAINTENANCE DATA for asset data requirements
- B. The Contractor is responsible for incorporating Design Intent Model and Facility Asset Data Spreadsheet revisions into the Construction and As-Built Model(s) in order to maintain an up-to-date basis for Building Information Modeling throughout construction.
- C. Contractor is responsible for incorporating the following Asset Data from SF Facility Asset Data Spreadsheet into the Construction and As-Built Model(s):
 - 1. Asset ID# (SI will provide)
 - 2. Asset Name (SI will provide)
 - 3. SpecID (CSI Master Format 2016)
 - 4. Manufacturer
 - 5. Description

2.5 DEVELOPMENT OF CONSTRUCTION MODEL(S)

- A. The intent of the Construction Model(s) is to communicate the necessary information to construct the facility including size, location, and arrangement of both existing to remain and new elements and to incorporate the as-built conditions.
- B. Develop Construction Model(s) based upon Contract Documents, Design Intent Model(s), and verified existing conditions.
- C. Construction Model(s) shall accurately reflect the geometry and details of existing and new elements within the facility.
 - 1. Use manufacturer or custom model elements to accurately reflect the components detailed in documents submitted for approval.
 - 2. Update the model elements to accurately reflect any revisions to geometry or details arising from the submittal review process.
- D. Construction Model(s) are to have a consistent origin that can be referenced to a real world datum or benchmark, located as required in the “SF Revit Template Users’ Guide”.
- E. Quality Control. The Construction Model(s) will undergo automated model checks utilizing rulesets, as described in the “SF BIM Guidelines” document and visual review by SI.
- F. The Construction Model(s) are to reflect all necessary access and clearances.
- G. The Construction Model(s) will include, but not be limited to, the following elements with all necessary intelligence included to produce plans, sections, elevations, riser diagrams, and schedules as applicable:
 - 1. Substructure: All foundations, subgrade enclosures, slabs-on-grade, and water and gas utility connections. Substructure elements shall be depicted with all necessary recesses, curbs, pads, slopes, closure pours, expansion/construction joints, and major penetrations depicted.

2. Shell: All superstructure, exterior vertical enclosures, and exterior horizontal enclosures, including a depiction of expansion/construction joints.
 - a. Superstructure: All columns, primary and secondary framing members, and bracing for the roof and floor systems (including decks).
 - b. Exterior Vertical Enclosures: Exterior vertical enclosures shall be depicted to the exact height, length, width, and ratings (thermal, acoustic, fire) to properly reflect element types. Exterior windows, doors and grilles including hardware sets, louvers and vents, and wall appurtenances shall be depicted to represent their actual size, type and location.
3. Interiors: All interior partitions, windows, doors and grilles, louvers, and vents, raised floors, and ceilings, depicted to represent their exact location, height, length, width, and ratings (thermal, acoustic, fire) to properly reflect element types.
4. Services: All elevators, escalators, plumbing, HVAC, fire protection, electrical, communications, electronic safety and security, and integrated automation elements, including all major openings and penetrations, cable trays, cable bundles and pipe grouping. All clearances and insulation shall be accounted for in the model for use in interference management and maintenance access requirements. Nonpermanent items are not required to be modeled or contain facility data.
 - a. Plumbing: All plumbing elements including plumbing piping and fixture layouts, floor and area drains, and related equipment.
 - b. Heating, Ventilation, And Air Conditioning (HVAC): All heating, ventilation, and air conditioning (HVAC) elements including piping, valves, ductwork fixture layouts and related equipment.
 - c. Fire Protection: All fire protection elements including piping, valves, and related equipment.
 - d. Electrical: All electrical elements including conduit, fixture layouts and related equipment (including power for systems furniture).
 - e. Communications: All communications and low voltage systems elements including conduit and related equipment.
 - f. Security: All Electronic Safety and Security elements including conduit and related equipment.
 - g. Integrated Automation: All integrated automation elements including conduit and related equipment.
 - h. Model all elements larger than 38mm (1-1/2 inch) in diameter for any trade. When equal or smaller element are grouped or run in a uniform path. That group of elements shall be modeled when larger than 152mm (6 inches).
5. Equipment and Furnishings: All fixed equipment and furnishings, depicted to represent their exact location, height, length, width, configuration, materials, finishes, and mechanical and electrical requirements.
6. Special Construction and Demolition: All special construction and demolition including special construction, facility remediation and demolition
7. Sitework: All sitework elements, including site improvements, liquid and gas utilities, electrical site improvements, and site communications.

H. Construction Model(s) must be revised and certified by the Contractor prior to installation of facility elements contained within the models.

2.6 DEVELOPMENT OF COORDINATION MODEL(S)

- A. Develop Coordination Model(s) that combine facility elements contained within the Construction Models with other facility elements depicted in the Design Intent Model to review the efficiency and harmony of the relationship of the facility elements.

- B. Verify that all facility elements are properly represented within the Construction and Coordination Model(s) prior to coordination.
- C. Conduct the following interferences checks to ensure that there are no conflicts in the installation of facility elements.
 - 1. Substructure/Shell vs Interiors
 - 2. Substructure/Shell vs Equipment and Furnishings provided by Contractor
 - 3. Interiors vs Equipment and Furnishings provided by Contractor.
 - 4. Substructure vs. Shell
 - 5. Services vs other components:
 - a. Services vs Substructure/Shell
 - b. Services vs Interiors
 - c. Services vs Equipment and Furnishing
 - d. Services vs Site work
 - 6. Services
 - a. Plumbing vs HVAC
 - b. Plumbing vs Fire Protection
 - c. Plumbing vs Electrical
 - d. Plumbing vs Communications
 - e. Plumbing vs Electronic Safety and Security
 - f. HVAC vs Fire Protection
 - g. HVAC vs Electrical
 - h. HVAC vs Communications
 - i. HVAC vs Electronic Safety and Security
 - j. Fire Protection vs Electrical
 - k. Fire Protection vs Communications
 - l. Fire Protection vs Electronic Safety and Security
 - m. Electrical vs Communications
 - n. Electrical vs Electronic Safety and Security
 - o. Communications vs Electronic Safety and Security
 - 7. ADA Accessibility
- D. Coordination Model(s) shall be free of interferences prior to installation of any associated facility element.
- E. Update the Coordination Model(s) to reflect changes throughout construction prior to installation of any associated facility element.

2.7 COORDINATION REPORT(S)

- A. Develop Coordination Reports identifying outstanding issues after the development of the Coordination Model(s), including but not limited to:
 - 1. Clashes:
 - a. Itemize number of clashes.
 - b. Clash Category
 - c. Describe clashes.
 - d. Describe the resolution of clashes and other conflicts.
 - 2. Design changes.
 - 3. Differing site conditions.
 - 4. Hazardous or safety related issues.
 - 5. Assets installed and assets pending installation.

- B. The report shall be organized by CSI Master Format 2016 specification section or by trade
- C. The issues identified within the Coordination Report are to be addressed by the **Contractor** in consultation with the SI and the Architect / Engineer prior to installation of facility elements.
- D. The Contractor is solely responsible for the cost of remedying any clashes that could have been discovered during the clash detection process.

2.8 INSTALLATION

- A. Install facility elements in accordance with approved Construction Model(s), Fabrication/Shop Drawings, Coordination Model(s), and Coordination Reports. Any variance from these documents shall require approval by the SI C O T R prior to the installation of the associated facility elements.
- B. Adjust Coordination Model(s) throughout construction to reflect all changes made to the approved Contract Drawings and Specs, Design Intent Model, and Fabrication/Shop Drawings.
- C. Maintain an up-to-date Fabrication/Shop Drawing set and Coordination Model(s) for all parties to access.

2.9 AS-BUILT MODEL AND DRAWINGS

- A. Upon completion of the installation of facility elements, update and deliver As-Built Model(s) and Fabrication/Shop Drawings to document the condition of the facility upon completion of construction.
 - 1. The updated Construction and Coordination Model(s) are considered the As-Built Model for this facility. These models shall clearly indicate portions of the facility that are constructed and portions where construction is pending.
 - 2. As-Built Model(s) shall be field verified for accuracy and updated as required. The Level of Development (LOD) shall be LOD 500
 - 3. The Level of Accuracy (LOA) of the model(s) shall be minimal 12mm (1/2") for existing and align with construction tolerances for all new construction.
 - 4. Model(s), CAD and SI-GIS exports are to be delivered in native file formats as well as file formats and naming conventions consistent with SF standards. Reference the "SF Revit Templates Users Guide" and "Smithsonian Facilities BIM Guidelines" guidance documents.
 - 5. All models shall be linked and submitted using Autodesk Navisworks.

END OF SECTION 01 3250

**SECTION 01 7823
OPERATION AND MAINTENANCE DATA**

1.1 RELATED DOCUMENTS

- A. The Contract Documents in their entirety, including the Drawings, Specifications, Construction Contract Clauses, and any other documents issued as part of the Contract, apply to this Section. All submittal documentation shall be submitted in a PDF format plus program file and hard copies as required.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals and Facility Asset Data including, but not limited to, the following:
1. Operation and maintenance documentation directory.
 2. Emergency manuals.
 3. Operation manuals for systems, subsystems, and equipment.
 4. Product maintenance manuals.
 5. Systems and equipment maintenance manuals
 6. Transfer of Building Equipment Asset Facility Data.
 7. Collection and Handover of Facility Data.
 8. Equipment and System Warranties
- B. Related Requirements:
1. Division 01 section BUILDING INFORMATION MODELING (BIM) REQUIREMENTS for building information modeling (BIM) requirements.
 2. Division 02 through 33 sections for specific operation and maintenance manual requirements for the work in those sections.
- C. Contractor's Responsibility:
1. Develop deliverables required in this Section.
 2. Contractor is solely responsible for the quality and accuracy of all documentation and submittals of this Section.

1.3 DEFINITIONS

- A. Facility Breakdown Structure: a system-oriented hierarchical decomposition of a facility into smaller components. Typically, the facility breakdown structure is based on disciplines and trades described by CSI Master Format 2016.
- B. Facility Asset Data: Pre-Defined set of attributes that defines various characteristics of an object.
- C. Product Data: Illustrations, standard schedules, performance charts, instructions, brochures, diagrams, manufacturer's descriptive literature, and catalog information illustrating a material, product, or system to be installed on this project.
- D. Material Safety Data Sheets: Instructions, warnings, and recommended and required handling and use procedures for individual hazardous materials published by the product manufacturer. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- E. Subsystem: A portion of a system with characteristics similar to a system.

1.4 QUALITY ASSURANCE

- A. Maintenance Manual Preparation: In preparation of Maintenance Manuals, use personnel thoroughly trained and experienced in operation and maintenance of the equipment or system involved.
 - 1. Where written instructions are required, use personnel skilled in technical writing to the extent necessary for communication of essential data.
 - 2. Where Drawings or diagrams are required, use draftsmen capable of preparing Drawings in a clear and understandable format, reference “SF CAD Guidelines” and/or “SF BIM Guidelines” for additional requirements.

- B. Instructions / Training for SI Personnel: For instruction of the SI’s operations and maintenance personnel, use experienced instructors thoroughly trained and experienced in the operation and maintenance of the building equipment or system involved.
 - 1. Prior to final inspection, instruct SI personnel in operation, adjustment, and maintenance of products, equipment and systems. Provide instruction at mutually agreed upon times.
 - a. For equipment that requires seasonal operation, provide similar instruction during other seasons.
 - b. Use operation and maintenance manuals for each piece of equipment or system as the basis of instruction. Review contents in detail to explain all aspects of operation and maintenance.
 - c. Video Training may be required based on complexity, COTR to determine if required.

1.5 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. COTR 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 COTR.
 - a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically bookmarked operation and maintenance directory.
 - 2. Three paper copies. Include a complete operation and maintenance directory.

- C. Initial Manual Submittal: Submit draft copy of each manual within 45 working days of receipt of approved equipment submittal.
 - 1. COTR will comment on whether general scope and content of manual are acceptable and will return one copy within 15 working days of receipt.

- D. Final Manual Submittal: Submit each manual in final form at least 45 working days before commencing demonstration and training and/or final inspection.
1. After demonstration and training and/or final inspection COTR will return one copy with comments within 15 working days.
 2. Submit final approved manual(s) to the COTR within 15 working days of receipt of COTR comments.
- E. Warranties
1. Submittal: Submit written warranties on request of COTR 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.
 2. Partial Occupancy: Submit properly executed warranties within 15 working 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.
- F. Facility Asset Data:
1. Submittals:
 - a. Submit SF Facility Asset Spreadsheet(s) with equipment submittal(s) for review / approval
 - b. Submit monthly updates of the SF Facility Asset Spreadsheet(s) that include data, assets and attributes of all components being installed and / or removed. Spreadsheet(s) should reflect work completed the previous month.

PART 2 - EXECUTION

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

- A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data, listing items and their location to facilitate ready access to desired information. Include a section in the directory for each of the following:
1. List of documents.
 2. List of systems and subsystems.
 - a. List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
 3. List of equipment.
 - a. List equipment for each system alphabetically organized by system. For pieces of equipment not part of system, list alphabetically in separate list.
 4. Table of contents.
 - a. Include a table of contents for each manual.
- B. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

2.2 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page: Include the following information
 - a. Name and address of Project.
 - b. Name and address of Owner: SMITHSONIAN INSTITUTION, WASHINGTON, DC
 - c. Date of submittal.
 - d. Subject matter included in manual
 - e. Name and contact information for Contractor and Sub-Contractor(s).
 - f. Name and contact information for Architect and Engineer(s)
 - g. Cross-reference to related systems in other operation and maintenance manuals.
 2. Table of contents.
 - a. List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 - b. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
 3. Manual contents.
 - a. Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- B. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree.
- C. Not Used

2.3 EMERGENCY MANUALS

- A. Content: Organize manual into a separate section for each of the following:
1. Type of emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
 - a. Fire.
 - b. Flood.
 - c. Gas leak.
 - d. Water leak.
 - e. Power failure.
 - f. Water outage.
 - g. System, subsystem, or equipment failure.
 - h. Chemical release or spill.
 2. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
 3. Emergency Procedures: Include the following, as applicable:
 - a. Instructions on stopping.

- b. Shutdown instructions for each type of emergency.
- c. Operating instructions for conditions outside normal operating limits.
- d. Required sequences for electric or electronic systems.
- e. Special operating instructions and procedures.

2.4 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents and SF Facility Asset Spreadsheet(s). Include the following:
 - a. Asset ID # (SI Provided)
 - b. Asset Name (SI Provided)
 - c. Product name and model number. Use designations for products indicated on Contract Documents.
 - d. Manufacturer's name.
 - e. Equipment identification with serial number of each component.
 - f. Equipment function.
 - g. Operating characteristics.
 - h. Limiting conditions.
 - i. Performance curves.
 - j. Engineering data and tests.
 - k. Complete nomenclature and number of replacement parts.
 2. Performance and design criteria if Contractor has delegated design responsibility.
 3. Operating standards.
 4. Operating procedures, 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. Instructions on stopping.
 - f. Normal shutdown instructions.
 - g. Seasonal and weekend operating instructions.
 - h. Required sequences for electric or electronic systems.
 - i. Special operating instructions and procedures.
 5. Operating logs.
 6. Wiring diagrams.
 7. Systems and Equipment Controls
 - a. Describe the sequence of operation, and diagram controls as installed.
 8. Piped systems diagrams.
 9. Precautions against improper use.
 10. License requirements including inspection and renewal dates.
 - a. Include copy of all final inspection reports
- B. Coordination Drawings: Provide each Contractor's Coordination Drawings.
1. Provide as-installed color-coded piping diagrams, where required for identification.
- C. Valve Tags:
1. Provide charts of valve tag numbers, with the location and function of each valve.
- D. Circuit Directories:
1. For electric and electronic systems, provide complete circuit directories of panel boards,

including the following: a. Electric service.

- a. Controls.
- b. Communication.

2.5 PRODUCT MAINTENANCE MANUALS

- A. Provide one section for architectural products, including applied materials and finishes, and a second for products designed for moisture- protection and products exposed to the weather.
 1. Refer to individual Specification Sections for additional requirements on care and maintenance of materials and finishes.
- B. ARCHITECTURAL PRODUCTS
 1. Content: Organize manual into a separate section for each product, material, and finish. Include the following as applicable:
 - a. Product information
 - b. Maintenance procedures
 - c. Repair materials
 - d. Source Information
 - i 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.
 2. Product Information: Include the following, as applicable:
 - a. Product name and model number.
 - b. Manufacturer's name.
 - c. Color, pattern, and texture.
 - d. Material and chemical composition.
 - e. Reordering information for specially manufactured products.
 3. Care and Maintenance Procedures: Include manufacturer's written recommendations and 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. Schedule for routine cleaning and maintenance.
 - e. Repair instructions.
 4. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- C. MOISTURE-PROTECTION AND WEATHER EXPOSED PRODUCTS
 1. Content: Organize manual into a separate section for each product, material, and finish. Include the following as applicable:
 - a. Product information
 - b. Maintenance procedures
 - c. Repair materials
 - d. Source Information.
 - i 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.
 2. Manufacturer's Data: Provide manufacturer's data giving detailed information, including the following, as applicable:

- a. Applicable standards.
- b. Chemical composition.
- c. Installation details.
- d. Inspection procedures.
- e. Maintenance information.
- f. Repair procedures.

2.6 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Content: Organize manual into a separate section for each system, subsystem, and piece of equipment not part of a system, include the following as applicable:
1. Source information
 - a. List each system, subsystem, and piece of equipment included in manual, identified by product name, and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
 2. Manufacturers' Maintenance Documentation: Including the following information for each component part or piece of equipment:
 - a. Standard maintenance instructions and bulletins.
 - b. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 - c. Identification and nomenclature of parts and components.
 - d. List of items recommended to be stocked as spare parts.
 3. Maintenance procedures: Include the following information and items that detail essential maintenance procedures:
 - a. Test and inspection instructions.
 - b. Troubleshooting guide.
 - c. Precautions against improper maintenance.
 - d. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - e. Aligning, adjusting, and checking instructions.
 - f. Demonstration and training video recording, if available.
 4. Maintenance and Service schedules
 - a. Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 - i Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semi-annual, and annual frequencies.
 - ii Maintenance and Service Record: Include manufacturers' forms for recording maintenance
 5. Spare Parts List and Source Information
 - a. Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
 6. Maintenance service contracts
 - a. Include copies of maintenance agreements with name and telephone number of service agent.

2.7 WARRANTIES

- A. Submission of original warranties for all products, equipment, and systems.

1. The Contractor shall assemble original warranty certificates or notarized copies of warranty certificates executed by the Contractor, Subcontractors, suppliers, and manufacturers. Provide electronic copy in PDF format. The table of contents shall identify:
 - a. Asset ID # (SI Provided)
 - b. Asset Name (SI Provided)
 - c. Date of Substantial Completion
 - d. Expiration date of the warranty
 - e. Supplier
 - f. Vendor
 - g. Installing Contractor
2. Each warranty certificate or bond shall identify the date(s) for:
 - a. Substantial Completion status in accordance with project closeout requirements.
 - b. Beginning and ending of the warranty period.
 - c. The Contractor shall provide any coincidental product warranty, which is available on a product incorporated in the Work, but for which the warranty is not specifically required by the contract documents.
 - d. List(s) of circumstances and conditions that would affect validity of warranties or bonds.
 - e. Include procedures to follow and required notifications for warranty claims.
 - f. Provide any extended warranties offered by manufactures and/or installers (including labor) for all equipment for Owner to review.
3. Warranty of Construction: The Contractor shall warrant that the work performed under this contract conforms to the contract requirements and is free of any defect in equipment, materials, design furnished or workmanship performed by the Contractor or any subcontractor or supplier at any tier. Unless otherwise stated in the technical sections of the Specifications, the warranty of the Work shall continue for a period of one (1) year from the date of Final Completion status. If the Smithsonian takes partial occupancy before Final Completion, then the warranty for that portion shall be in effect for a period of one (1) year beginning on the date of Substantial Completion for that portion of the Work

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.
- B. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- C. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- D. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 2. Prepare a separate manual for each system and subsystem, in the form of an instructional

manual for use by Owner's operating personnel.

- E. 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.
- F. 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.

3.2 WARRANTIES

- A. The Contractor shall assemble original warranty certificates or notarized copies of warranty certificates executed by the Contractor, Subcontractors, suppliers and manufacturers

3.3 FACILITY ASSET DATA

- A. Design Intent Facility Asset Data Spreadsheet will be provided to the Contractor to be used in the development of Facility Asset Data. The Design Intent Facility Asset data spreadsheet communicates the creative objectives of the and is not intended to be used for direct import into Facility Center in that the assets and attributes contained within it are suitable as a basis of design only, and will require verification, updating, and supplementation by the Contractor.
- B. Facility Asset Data shall include attributes for assets as defined in spreadsheet(s) provided by SI. Please refer to the SF Facility Asset Data Spreadsheet for data fields (parameters) and requirements.

END OF SECTION 01 7823

PENETRATION FIRESTOPPING – SECTION 078413
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PENETRATION FIRESTOPPING – SECTION 078413

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provision of Contract, including General and Special Conditions and Division 1 Specification Section, apply to work of this section.

1.02 SUMMARY

- A. Firestopping is defined as furnishing and installing tested and listed firestopping systems, combinations of materials, or devices to form an effective barrier against the spread of flame, smoke and gases, and maintain the integrity of fire resistance rated walls, partitions, floors, and ceiling-floor assemblies, including through-penetrations and construction joints and gaps.

1.03 ALLOWANCES

1.04 UNIT PRICES

1.05 DEFINITIONS

- A. COTR: Contracting Officer Technical Representative
- B. FM: FM Global (Factory Mutual)
- C. FPE: Fire Protection Engineer
- D. Furnish: To supply the stated equipment or materials
- E. Install: To set in position and connect or adjust for use
- F. NFPA: National Fire Protection Association
- G. NICET: National Institute for Certification in Engineering Technologies
- H. OSHM: Office of Safety Health and Environmental Management
- I. Provide: To furnish and install the stated equipment or materials
- J. UL: Underwriters Laboratories

1.06 SYSTEM DESCRIPTION

- A. Firestopping shall be provided in the following locations:
 - 1. Construction Joints: includes those used to accommodate expansion, contraction, wind, or seismic displacement. The firestopping material shall be a dynamic system and shall not detract from the intended movement of the joint.
 - 2. Penetrations through floor slabs, fire-rated partitions, fire walls, and exterior walls where rated. Firestopping shall be provided for all new penetrations; penetrations left open by demolition/removal of duct, cable, conduit, and pipe; damaged firestopping, and existing abandoned penetrations in the contract area. Unless otherwise specified or shown on the drawings, the Contractor shall assume that all floor slabs are two-hour, fire-rated. Locations of fire walls or partitions shall be indicated on the drawings.
 - 3. Penetrations of vertical shafts: assume a two-hour fire barrier unless noted otherwise.
 - 4. Around openings and penetrations through fire-rated floor/ceiling and roof/ceiling assemblies.

5. Joint systems for floor-to-floor, wall-to-wall, floor-to-wall, and head of wall applications.

B. Other locations shown specifically on the drawings or where called for in other sections of the specifications.

1.07 PERFORMANCE REQUIREMENTS

A. Materials or combinations of materials used for firestopping shall be noncombustible and comply with the following as a minimum:

1. Flame Spread Index: 25 or less, as measured by ASTM E-84

a. Flame Spread Index (FSI) is a relative indication of the flammability of the material of interest with respect to a red oak standard. For example, an FSI of 25 indicates that a material has approximately 25% of the standard material's flame spread characteristics.

2. Smoke Developed Index: 100 or less, as measured by ASTM E-84

a. Smoke Developed Index (SDI) is a relative indication of the amount of smoke produced by a material when exposed to a certain heat source with respect to a red oak standard. The numbers carry the same meaning as the FSI values (25 indicates 25%).

B. Firestopping shall be asbestos free and shall be non-toxic to humans during installation and fire conditions

C. Examination Of Work By The Contractor

1. It shall be the responsibility of the prime contractor to provide firestopping for the entire project. The Contractor shall examine the area to receive firestopping prior to beginning work or to submitting the data required under 1.08, Submittals.

2. Data to be submitted shall be based on the findings of the Contractor's examination.

1.08 SUBMITTALS:

A. Submit the following for approval by the COTR and the OSHEM Fire Protection Engineer. Submit applicable data for each condition specified.

1. Certificates of conformance or compliance, accompanied by classification by a nationally recognized testing lab or by other supporting evidence satisfactory to the COTR and the OSHEM Fire Protection Engineer, that the material or combination of materials used meet the requirements specified for flame spread, smoke developed, and fire resistance.

2. Manufacturer's catalog data for all materials and prefabricated devices, including descriptions sufficient to identify them on the job, and instructions for installation. This data shall also include the Flame Spread Index and the Smoke Developed Index for the materials of interest.

3. Completed construction details (as-builts) showing material, reinforcement, anchorage, fastenings and method of installation. Catalog data with installation diagrams shall also be included. Clearly show which product will be used for each application. Firestopping materials of different manufacturers shall not be intermixed. Do not submit multiple products for the same application. Details for firestopping of penetrations and joint systems shall show compliance with the appropriate UL Design Number. Drawings shall accurately reflect job conditions pursuant to paragraph 1.07 C, Examination of the Work by Contractor.

4. Provide as-built drawings showing all penetration locations on floor plans. An identification key shall provide the rating and construction of the assembly penetrated, and the firestopping assembly used at each location.

1.09 QUALITY ASSURANCE

- A. Manufacturers Qualifications: 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.
 - 1. American Society for Testing and Materials (ASTM) Publications:
 - a) E84 Standard Test Method for Surface Burning Characteristics of Building Materials
 - b) E119 Standard Test Method For Fire Tests of Building Construction and Materials
 - c) E814 Test Method of Fire Tests of Through-Penetration Fire stops
 - d) E1966 Fire Resistive Joint Systems
 - e) E1399 Cyclic Movement And Measuring The Min & Max Joint Widths of Arch Joint Systems
 - 2. Underwriters Laboratories (UL) Publications:
 - a) UL-1479 Fire Tests of Through-Penetration Fire Stops
 - b) UL-2079 Tests for Fire Resistance of Building Joint Systems
 - c) FRD Fire Resistance Directory
- B. Installer's Qualifications. Provide data to show that the firm has at least two years of experience in the installation or application of systems similar in complexity to those required for this project. In addition, provide data to show that the firm is qualified by providing at least 5 comparable scale projects using the manufacturer's systems.
- C. Pre-Installation Conference
 - 1. Conduct a pre-installation conference with all sub-contractor representatives to verify project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to project site in original, unopened packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, and shelf life if applicable.
- B. Store materials indoors, under cover, above ground, away from moisture, and protected from physical damage until ready for use. Remove from site and discard wet or damaged materials.

1.11 PROJECT CONDITIONS

- A.

1.12 COORDINATION

- A. Coordinate installation of all penetration firestopping systems with mechanical, electrical, fire protection, and other trades so that installation is complete and to minimize rework due to the addition of penetrants or other modifications.

1.13 WARRANTY

- A. Provide a written warranty by the manufacturer against defects in manufacturing and materials and by the installer against defects in workmanship.

1.14 SERVICE AGREEMENT

- A.

1.15 EXTRA MATERIALS

A.

PART 2 - PRODUCTS

2.01 GENERAL

A. All firestopping used throughout the project shall be the products of a single manufacturer.

2.02 MANUFACTURERS

A. Hilti

B. 3M

C. Specified Technologies, Inc.

D. Nelson

E. Any manufacturer approved by OSHEM and the COTR

2.03 FIRE RESISTANCE RATING

A. Firestop systems shall be UL Fire Resistance listed or FM P7825a approved with an "F" rating at least equal to the fire-rating of the fire wall or floor in which penetrated openings are to be protected. The "F" rating is permitted to be 3 hours in through-penetrations of 4 hour fire rated walls or floors. Firestop systems shall also have "T" rating where required by any applicable code.

1. F Rating: a rating usually expressed in hours indicating a specific length of time that a fire resistive barrier can withstand fire before being consumed or permits the passage of flame through an opening in an assembly.
2. T Rating: a rating usually expressed in hours indicating the length of time that the temperature on the non-fire side of a fire-rated assembly exceeds 325 degrees above its ambient temperature.

2.04 THROUGH-PENETRATIONS

A. Firestopping materials for through-penetrations shall provide "F" and "T" fire resistance ratings in accordance with ASTM E 814 or UL 1479.

2.05 CONSTRUCTION JOINTS AND GAPS

A. Construction joints and gaps shall be provided with firestopping materials and systems that have been tested per ASTM E 119, ASTM E 1966 or UL 2079 to meet the required fire resistance rating. Systems installed at construction joints shall meet the cycling requirements of ASTM E 1399 or UL 2079.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION:

A. Prior to application, remove from surfaces all dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting or required fire resistance of the firestopping material for cast-in-place firestop devices. Formwork or metal deck to receive device prior to concrete placement and shall be sound and capable of supporting the device. Prepare surface as recommended by the manufacturer.

3.02 INSTALLATION:

- A. Install in accordance with approved construction drawings (shop drawings), approved manufacturer's literature, installation instructions, UL Design Number or UL Report, and the following requirements:
- B. Firestopping caulks must be installed in a neat and workmanlike manner. The finished installation shall have neat edge lines and a smoothed surface without excess masses of rough caulk on the surface of the wall.
- C. Firestopping materials shall completely fill the void space regardless of geometric configuration, subject to tolerances established by the manufacturer when intumescent materials are used.
- D. Apply firestopping materials at penetrations of insulated pipes and ducts, prior to application of the insulation. If insulation is already in place, remove it at the penetration prior to application of the firestopping materials, except where intumescent materials are used and removal is not necessary per manufacturer's instructions. Removed insulation shall be replaced with a material having equal thermal insulation characteristics and equal firestopping characteristics.
- E. Firestopping for filling voids in floors, in which the smallest dimension is 101 mm (4 inches) or more, shall support the same load as the floor is designed or shall be protected by a permanent barrier to prevent loading or traffic on the fire stopped area.
- F. Cable tray penetrations shall be protected by either UL-listed through penetration fire stop devices or through penetration fire stop systems that are re-enterable. Where penetrating cables in a cable tray are removed, replaced, or added, restoration shall be accomplished in an approved manner; the allowable number of penetrating items shall not be exceeded; only permitted penetrations shall be installed; and adequate clearances shall be maintained among penetrations, between penetrations, and the sides of the opening.
- G. Damaged, disrupted, or removed firestopping shall be replaced with new.
- H. Firestopping shall not be applied in conjunction with fire dampers, smoke dampers, or combination fire/smoke dampers unless specifically required by the damper manufacturer installation instructions.

3.03 INSPECTION

- A. Approved installation instructions shall be present at each work area prior to the beginning of work and a test installation shall be produced for quality check by the COTR and OSHEM Fire Protection Engineer. The test installation shall be subject to inspection and/or test for conformance with contract requirements. Periodic quality checks shall be performed at the discretion of the COTR, and should installation prove to be substandard, all firestopping installed up to that time, not meeting approved standards, shall be replaced at no additional cost to the Government.
- B. Area of work shall remain available for inspection by the COTR or his designated representative before and after application of firestopping.
- C. Notification: Notify the COTR or his designated representative at least 24 hours prior to installation of firestopping in each area to allow opportunity for inspection.
- D. The contractor shall submit written reports indicating locations of and types of penetrations and types of firestopping used at each location; type shall be recorded by UL listed printed numbers. Contractor records shall be maintained on site and provided to the COTR upon arrival for inspections.

3.04 ACCEPTANCE OF WORK

- A. Acceptance of Work: As work is completed, remove materials, litter, and debris. All work shall be inspected and accepted by the Contracting Officer and OSHEM Fire Protection Engineer before materials and equipment are moved to the next scheduled work area. Insulation work and/or ceiling and wall close-in shall not occur before OSHEM acceptance has been obtained.

- B. Labeling: Upon completion of unfinished areas only, affix label to or adjacent to each fire stopped penetration or joint assembly in fire-rated assemblies indicating material and proper replacement, if later disturbed. Suggested label is as follows:

<u>ATTENTION</u>	
THIS IS A FIRE-RATED ASSEMBLY	
BEFORE BREACHING	
CONTACT BUILDING MANAGER AND	
PROJECT COTR	
Hr Rating: _____	<u>Installed by:</u>
Install Date: _____	Company: _____
UL Design #: _____	Employee: _____

END OF SECTION 078143

**SECTION 092900
GYPSUM BOARD**

PART 2 - GENERAL

2.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Trim accessories.

2.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Locations and installation of control joints, including plans, elevations, sections, and attachment details.

C. Sustainable Design Submittals:

1. Laboratory Test Reports: For ceiling and wall materials, indicating compliance with requirements for low-emitting materials.

2.3 DELIVERY, STORAGE, AND HANDLING

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

2.5 FIELD CONDITIONS

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

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

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

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

3.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings in accordance with ASTM E119; tested by a qualified testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings in accordance with ASTM E90 and classified in accordance with ASTM E413; tested by a qualified testing agency.

3.2 GYPSUM BOARD, GENERAL

- A. Recycled Content: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 10 percent.
- B. Regional Materials: Verify materials were manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If materials are transported by rail or water, multiply the distance by 0.25 to determine the distance to Project site.
- C. Size: Provide panel products in maximum lengths and widths available that will minimize joints in each area and that correspond with support system specified or indicated on Drawings.

3.3 INTERIOR GYPSUM BOARD

- A. Gypsum Wallboard: ASTM C1396/C1396M.
 - 1. Thickness: As indicated on Drawings
- B. Gypsum Board, Type X: ASTM C1396/C1396M, ASTM E89.
 - 1. Thickness: As indicated on Drawings
- C. Impact-Resistant Gypsum Board: ASTM C1396/C1396M tested in accordance with ASTM C1629/C1629M.
 - 1. Core: 5/8 inch, Type X
 - 2. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds Level 2 requirements.
 - 3. Indentation: ASTM C1629/C1629M, meets or exceeds Level 2 requirements.
 - 4. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds Level 2 requirements.
 - 5. Hard-Body Impact: ASTM C1629/C1629M, meets or exceeds Level 2 requirements in accordance with test in Annex A1.
 - 6. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

3.4 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C475/C475M requirements.

1. Mold-Resistant Joint Compound: Use mold-resistant formulations with mold-resistant panel products.

B. Joint Tape:

1. Interior Gypsum Board: Paper.

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

1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
3. Fill Coat: For second coat, use setting-type, sandable topping compound.
4. Finish Coat: For third coat, use setting type sandable topping compound.
5. Skim Coat: For final coat of Level 5 finish, use high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish

3.5 AUXILIARY MATERIALS

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

B. Laminating Adhesive: Adhesive or joint compound recommended in writing by manufacturer for directly adhering gypsum panels to continuous substrate.

1. Verify adhesives have a VOC content of 50 g/L or less.

C. Steel Drill Screws: ASTM C1002 unless otherwise specified or indicated on Drawings.

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

PART 4 - EXECUTION

4.1 EXAMINATION

4.2 Examine areas and substrates including welded hollow-metal frames and support framing, with Installer

present, for compliance with requirements and other conditions affecting performance of the Work.

- 4.3 Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- 4.4 Proceed with installation only after unsatisfactory conditions have been corrected.

4.5 INSTALLATION AND FINISHING OF PANELS, GENERAL

- A. Comply with ASTM C840 requirements.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 requirements and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

4.6 INSTALLATION OF INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Gypsum Wallboard: As indicated on Drawings
 - 2. Gypsum Board, Type X: As indicated on Drawings
 - 3. Abuse-Resistant Gypsum Board: As indicated on Drawings

4. Impact-Resistant Gypsum Board: As indicated on Drawings

B. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated on Drawings.
2. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

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

4.7 INSTALLATION OF EXTERIOR GYPSUM BOARD FOR CEILINGS AND SOFFITS

A. Apply panels perpendicular to supports, with end joints staggered and located over supports.

1. Install with 1/4-inch open space where panels abut other construction or structural penetrations.
2. Fasten with corrosion-resistant screws.

4.8 INSTALLATION OF TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim in accordance with manufacturer's written instructions.
- B. Control Joints: Install control joints in accordance with ASTM C840 and in specific locations approved by COTR

4.9 APPLICATION OF JOINT TREATMENT MATERIALS

- A. Finishing Panel Products: Treat joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare panel surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over panel joints, except for trim products specifically indicated as not intended to receive tape.
- D. Interior Gypsum Board: Finish panels to levels indicated below and in accordance with ASTM C840:
1. Level 5:
 - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

4.10 PROTECTION

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

END OF SECTION 092900

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Primers.
2. Water-based finish coatings.
3. Solvent-based finish coatings.
4. Floor sealers and paints.
5. Dry fall coatings.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for shop priming metal fabrications.

1.3 ACTION SUBMITTALS

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

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

- B. Samples: For each type of topcoat product.

- C. Samples for Initial Selection: For each type of topcoat product.

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

1. Submit Samples on rigid backing, 8 inches (200 mm) square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

- E. Product Schedule: Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Paint Products: 10 percent, but not less than 2 gal. (7.6 L) of each material and color applied.

1.5 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
 - b. Other Items: Architect will designate items or areas required.
 - 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DEFINITIONS

- A. OTC as used in this Section refers to the Ozone Transmission Commission. OTC has established the following VOC levels for the Northeastern United States. Products shall meet the following OTC limits for VOC's.
 - 1. Interior flat paints: 100 grams per liter or less, per gallon.
 - 2. Interior enamels: 150 grams per liter or less, per gallon.
 - 3. Interior stains: 250 grams per liter or less, per gallon.
 - 4. Interior primers: 200 grams per liter or less, per gallon.
 - 5. Rust preventive coatings: 400 grams per liter or less, per gallon.
 - 6. Dry fog coatings: 400 grams per liter or less, per gallon.
 - 7. Floor coatings: 250 grams per liter or less, per gallon.
- B. DFT as used in this Section refers to the Dry Film Thickness of the coating.
- C. VOC as used in this Section refers to Volatile Organic Compounds found in primers, paints, sealers, and stains. The level of VOCs appears after each product listed in the Schedule in grams per liter (g/L).

- D. Paints are available in a wide range of sheens or glosses, as measured by a gloss meter from a 60 and/or 85 degree angle from vertical, as a percentage of the amount of light that is reflected. The following terms are used to describe the gloss of our products. The list below is provided for general guidance; refer to the technical data sheet for the actual gloss/sheen level for each product.
1. Flat/Matte: Less than 10 at 85 degrees.
 2. Eggshell: 10 - 22 at 85 degrees.
 3. Satin: 20 - 35 at 60 degrees.
 4. Semi-Gloss: 40 - 60 at 60 degrees.
 5. Gloss: 70 or greater at 60 degrees.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures of less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Benjamin Moore & Co
- B. Source Limitations: Obtain each paint product from single source from single manufacturer.

2.2 PAINT PRODUCTS, GENERAL

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

1. Twenty percent of surface area will be painted with deep tones.

2.3 PRIMERS

- A. Interior Latex Primer Sealer: Water-based latex sealer used on new interior plaster, concrete, and gypsum wallboard surfaces.
 1. Benjamin Moore All Purpose Primer
- B. Interior, Institutional Low-Odor/VOC Primer Sealer: Water-based primer sealer with low-odor characteristics and a VOC of less than 10 grams per liter for use on new interior plaster, concrete, and gypsum wallboard surfaces that are subsequently to be painted with latex finish coats.
 1. Benjamin Moore Fast Sanding Primer
- C. Water-Based Rust-Inhibitive Primer: Corrosion-resistant, water-based-emulsion primer formulated for resistance to flash rusting when applied to cleaned, interior ferrous metals subject to mildly corrosive environments.
 1. Benjamin Moore Alkyd Metal Primer
- D. Alkyd Quick-Dry Primer for Metal: Corrosion-resistant, solvent-based, modified-alkyd primer; lead and chromate free; formulated for quick-drying capabilities and for use on cleaned, interior steel surfaces.
 1. Benjamin Moore Universal Metal Primer

2.4 WATER-BASED FINISH COATS

- A. Interior, Latex, Institutional Low Odor/VOC, Low Sheen: White or colored latex paint with low-odor characteristics and a VOC of less than 10 grams per liter, for use in areas, such as hospitals and other occupied buildings, where the odor and VOC levels of conventional latex products would preclude their use.
 1. Benjamin Moore Regal Select Interior Paint Matte N548
 2. Gloss and Sheen Level: Manufacturer's standard Matte
- B. Interior, Latex, Institutional Low Odor/VOC, Eggshell: White or colored latex paint with low-odor characteristics and a VOC of less than 10 grams per liter, for use in areas, such as hospitals and other occupied buildings, where the odor and VOC levels of conventional latex products would preclude their use.
 1. Benjamin Moore Ultra Spec 500 Interior Eggshell Finish T538
 2. Gloss and Sheen Level: Manufacturer's standard eggshell finish
 - 3.

2.5 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Concrete: 12 percent.
 - 2. Fiber-Cement Board: 12 percent.
 - 3. Masonry (Clay and CMUs): 12 percent.
 - 4. Wood: 15 percent.
 - 5. Gypsum Board: 12 percent.
 - 6. Plaster: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Plaster Substrates: Verify that plaster is fully cured.
- E. Spray-Textured Ceiling Substrates: Verify that surfaces are dry.
- F. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- G. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

2.6 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
 - 1. SSPC-SP 2.
 - 2. SSPC-SP 3.
- G. Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Aluminum Substrates: Remove loose surface oxidation.
- J. Wood Substrates:
 - 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 - 2. Sand surfaces that will be exposed to view, and dust off.
 - 3. Prime edges, ends, faces, undersides, and backsides of wood.
 - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- K. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

2.7 INSTALLATION

- A. Apply paints according to manufacturer's written instructions.
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 - 1. Paint the following work where exposed in equipment rooms:
 - a. Equipment, including panelboards
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Tanks that do not have factory-applied final finishes.
 - h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - 2. Paint the following work where exposed in occupied spaces:
 - a. Equipment, including panelboards.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - h. Other items as directed by Architect.
 - 3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

2.8 FIELD QUALITY CONTROL

- A. Dry-Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry-film thickness.
 - 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 - 2. If test results show that dry-film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry-film thickness that complies with paint manufacturer's written recommendations.

2.9 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
 - 1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
 - 2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
 - 3. Allow empty paint cans to dry before disposal.
 - 4. Collect waste paint by type and deliver to recycling or collection facility.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

END OF SECTION 099123

SECTION 211313 – WET PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The following sections apply to the work of this section:
 - 1. 078413 Penetration Firestopping

1.02 SUMMARY

- A. Scope: Provide a complete, code compliant wet pipe sprinkler system, and associated equipment, ready for operation.
- B. The work includes designing and modifying an automatic wet-pipe fire extinguishing sprinkler system for Ordinary Hazard II and uniform distribution of water by hydraulic design to afford complete fire protection coverage throughout the contract area.
- C. Authority Having Jurisdiction: Any reference in the specifications or applicable codes to the "authority having jurisdiction" shall be interpreted to mean the OSHEM Fire Protection Engineer.

1.03 DEFINITIONS

- A. COTR: Contracting Officer Technical Representative
- B. FM: FM Global (Factory Mutual)
- C. FPE: Fire Protection Engineer
- D. Furnish: To supply the stated equipment or materials
- E. Install: To set in position and connect or adjust for use
- F. NFPA: National Fire Protection Association
- G. NICET: National Institute for Certification in Engineering Technologies
- H. OSHEM: Office of Safety Health and Environmental Management

- I. Provide: To furnish and install the stated equipment or materials
- J. UL: Underwriters Laboratories

1.04 SYSTEM DESCRIPTION:

- A. The design shall conform to NFPA 13 and the requirements specified herein. Design of the automatic wet pipe sprinkler system shall be for Ordinary Hazard II occupancy and as required by NFPA 13 by hydraulic calculation. The design, equipment, materials, installation, workmanship, examination, inspection and testing shall be in strict accordance with NFPA 13, except as modified herein.
- B. The system shall include all materials, accessories, and equipment inside and outside the building to provide a system complete and ready for use.
- C. Design and provide each system giving full consideration to obstructions, blind spaces, piping, electrical equipment, duct work and other construction equipment in accordance with detailed drawings to be submitted for approval.
- D. Equipment for fire protection service shall be UL listed or FM approved for use in wet pipe sprinkler systems.
- E. In the NFPA publications referred to herein, the advisory provisions shall be considered mandatory, as though the word "shall" had been substituted for "should," wherever it appears.

1.05 PERFORMANCE REQUIREMENTS

- A. Water Distribution: Distribution shall be uniform throughout the area which it is assumed the sprinkler heads will open. Variation in discharge from individual heads in the hydraulically most remote area shall be between 100 and 120 percent of the specified density.
- B. Piping Restrictions: Piping is prohibited in the following areas, except when solely supplying sprinklers in such areas:
 - 1. Transformer, switchgear, or similar rooms
 - 2. Elevator machine rooms and elevator shafts.
 - 3. IT Computer spaces (mission critical).
 - 4. Collection storage rooms.
- C. Clearance From Electrical Equipment: Piping and automatic sprinklers are prohibited directly over:
 - 1. Transformers.
 - 2. Switchboards.
 - 3. Motor control centers.
 - 4. Emergency generators.
 - 5. Bus Ducts.
 - 6. Electrical panels.
- D. If installing pipe over electrical equipment is unavoidable, provide drip pans under piping to protect electrical equipment.
- E. Location of Sprinkler Heads: Heads in relation to the ceiling and the spacing of sprinkler heads shall not exceed their listed area of coverage for Ordinary Hazard II. Uniformly space sprinklers on the branch piping. Locate sprinkler heads in a consistent pattern with ceiling grid, lights, and supply air diffusers.
- F. Sprinkler Discharge Area: The sprinkler discharge area shall be the hydraulically most remote areas as defined in NFPA 13. Remote area reductions permitted per NFPA 13 shall not apply.

- G. Hose Allowances: System design shall include an allowance of 100 gpm (6.31 l/s) for inside hose stream, and 250 gpm (15.77 l/s) for total combined inside and outside hose streams.
- H. Hydraulic Calculations: Hydraulic calculations shall be in conformance with NFPA 13 and the following requirements:
 - 1. Margin of Safety: The sprinkler system shall be hydraulically designed so that the total waterflow and pressure demand is at least 10% less than the available water flow and pressure at the site.
 - 2. Friction Losses: Calculate losses in piping in accordance with the Hazen- Williams formula with "C" value of 100 for unlined ductile iron piping, 120 for steel piping, 140 for cement-lined ductile-iron piping, 150 for copper tubing and plastic piping.
 - 3. Flow Velocity: Piping shall be sized so that the water flow velocity does not exceed 20 ft/sec (6.1 m/s) at any point in the system during maximum water flow (including inside hose demand). Flow velocity in each pipe segment is to be provided in the calculations.
 - 4. Test Point: Calculations shall be brought back to the flow test point.
 - 5. Area of Coverage and Density: The area of coverage and density for each sprinkler shall be provided in the calculations.
 - 6. Equivalent Lengths: The equivalent lengths for all types of fittings and valves used shall be provided.

1.06 SUBMITTALS

- A. Partial submittals will not be acceptable. Any installation work performed prior to the approval of the submittal shall be at the Contractor's own risk.
- B. Before any work is commenced, submit manufacturer's data (with listing or approval), system calculations, [water supply data,] and complete sets of working drawings.
- C. The OSHEM Fire Protection Engineer shall review and approve submittals.

- D. Manufacturers' Data: Annotate descriptive data to show the specific model, type and size of each item the Contractor proposes to furnish. Include data for proper installation of each system including:
1. Pipe and fittings
 2. Alarm Valves
 3. Gate and check valves
 4. Globe valves
 5. Backflow preventers
 6. Water motor alarms
 7. Sprinkler heads
 8. Pipe hangers and supports
 9. Pressure and waterflow switches
 10. Tamper switches
 11. Inspector's test station
 12. Retard chamber
 13. Ball drip
 14. Fire Department Connections
 15. Lubricating compound / PTFE tape
 16. Signs
 17. Caps, Chains
 18. Cabinets
 19. Hose Valves
 20. Drip pans

- E. Shop Drawings: Prepare working drawings on sheets not smaller than 24 in by 36 in (610 mm by 914 mm), in accordance with the requirements for "Working Plans" as specified in NFPA 13. A scaled site plan, with the location and elevation of the water flow test, shall be provided on the drawings.
- F. As-Built (Record) Working Drawings: On a weekly basis, the Contractor Superintendent, in conjunction with the COTR, shall review and record as-built conditions on a set of drawings maintained at the job site. After completion, but before final acceptance of the work, furnish a complete set of as-built drawings for review and approval by OSHEM. Make all necessary corrections to the drawings and furnish four sets of as-built drawings for record purposes. All deviations from the approved shop drawings shall be highlighted on the as-built drawings; if required by OSHEM the Contractor shall also provide hydraulic calculations justifying deviations. The drawings shall not be smaller than 24 in by 36 in (610mm by 914 mm) on reproducible sepia with title block similar to full size contract documents. Submit electronically CAD based drawings in DXF and PDF based format of all as-built drawings and schematics.
- G. Operation and Maintenance Manuals: Furnish four (4) instruction manuals containing complete operation and maintenance instructions for the specific make and model of all check valves, detector check valves, alarm valves, waterflow and tamper switches, backflow preventers, and other trim furnished. Serial numbers and ordering information shall be provided. Place one copy of each instruction manual in a flexible, oil-resistant protective binder and mount in an accessible location in the vicinity of each alarm control valve. Furnish three additional copies of each instruction manual.

1.07 QUALITY ASSURANCE

- A. 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. All publications listed below refer to the most current edition.
- B. Manufacturers Qualifications
 - 1. American Society for Testing and Materials (ASTM) Publications
 - a. A53 Pipe, Steel, Black and Hot Dipped, Zinc-Coated, Welded and Seamless
 - b. A135 Welded and Seamless Steel Pipe
 - 2. Factory Mutual System (FM) Publications
 - a. Approval Guide

3. National Fire Protection Association (NFPA) Publications
 - a. 13 Standard for the Installation of Sprinkler Systems
 - b. 14 Standard for the installation of Standpipe and Hose Systems
 - c. 70 National Electrical Code
 - d. 72 National Fire Alarm and Signaling Code
 - e. 101 Life Safety Code
 - f. 291 Recommended Practice for Fire Flow Testing and Marking of Hydrants
 - g. 1963 Standard for Fire Hose Connections
 4. International Code Council (ICC)
 - a. International Building Code
 5. Underwriters Laboratories, Inc. (UL) Publications:
 - a. Fire Protection Equipment Directory
 - b. 262 Gate Valves for Fire Protection Service
 - c. 789 Indicator Posts for Fire Protection Service
 6. American Society of Mechanical Engineers (ASME)
 - a. A17.1 Safety Code for Elevators and Escalators
- C. Qualifications Of Installer:
1. Prior to installation, submit data for approval by OSHEM, showing that the Contractor has successfully installed automatic wet pipe fire extinguishing sprinkler systems of at least 200 sprinkler heads each, or there is a firm contractual agreement with a subcontractor having such required experience. These systems shall be the same type and design which have been retrofitted into existing museums and historical buildings as specified herein. The data shall include the names and locations of at least two installations where the Contractor, or the subcontractor referred to above, has installed such systems. The Contractor shall indicate the type and design of each system and certify that each

system has performed satisfactorily in the manner intended for a period of not less than 18 months.

2. Design (including hydraulic calculations) shall be by a NICET Level III or IV Technician (in automatic sprinkler system design) or a Professional Engineer (P.E.), licensed in Fire Protection Engineering. Qualifications of the designer must be submitted to OSHEM for approval. The designer's NICET or P.E. stamp shall be present on each sheet of the working drawings.
- D. Service Organization: The Contractor shall furnish, to the COTR, evidence that there is an experienced and effective service organization which carries a stock of repair parts for the system in order to readily conduct repairs throughout the warranty period. Should the Contractor fail to comply with the service requirements of this section, the Government will then have the option to make the necessary repairs and back charge the Contractor without any loss of warranty or guarantee as provided by the contract documents.

1.10 DELIVERY STORAGE AND HANDLING

- A. Deliver products to project site in original, unopened packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, and shelf life if applicable.
- B. Store materials inside, under cover, above ground, kept dry and protected from physical damage until ready for use. Remove from site and discard wet or damaged materials.
- C. Automatic sprinklers must be kept in original packaging until they are installed. Loose carrying or storage is not permitted. Loose sprinklers shall be discarded immediately and replaced at Contractor's expense.

1.11 COORDINATION

- A. Coordinate sprinkler head layout with reflected ceiling plan and all ceiling – mounted equipment, including diffusers, lights, security cameras, fire alarm devices, exit signs, and other devices.
- B. Coordinate major equipment and piping layouts with other trades to avoid obstructions and excessive changes in direction for piping.

1.12 WARRANTY

- A. The Contractor shall guarantee labor, materials, and equipment provided under this contract against defects for a period of one year after the date of final acceptance of this work by the Government.
- B. Final acceptance includes, but is not limited to, the receipt and OSHEM

approval of, as-built drawings and operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. All products are subject to the following listed acceptable manufacturers. If the product is not addressed herein the product shall be from a US based manufacturer and listed or re protection use.
- B. All products shall be FM approved/UL listed.
- D. Fire Protection Valves and Drain Assemblies
 - 1. Tyco Fire & Building Products
 - 2. Victaulic
 - 3. Stockham
 - 4. Kennedy
 - 5. Jenkins
 - 6. Reliable Automatic Sprinkler Co.
 - 7. Viking Corporation
- F. Sprinklers
 - 1. Tyco Fire & Building Products
 - 2. Reliable Automatic Sprinkler Co.
 - 3. Viking Corporation
 - 4. Victaulic Corporation
- G. Valve Supervisory Switches
 - 1. Potter Electric Signal

2. System Sensor
3. McWane, In. Kennedy Valve Div.

2.02 ABOVEGROUND PIPING SYSTEMS

- A. Provide fittings for changes in direction of piping and for all connections. Arrange piping so that it can be drained at the main riser. Make changes in piping sizes through standard tapered, reducing pipe fittings; the use of bushings is not permitted. Perform welding in the shop; field welding is not permitted.
- B. Jointing compound for pipe threads shall be polytetrafluoroethylene (PTFE) pipe thread tape only, applied on the male threads.
- C. Use of pipe dope is not permitted.
- D. Lubricant used on gaskets for mechanical fittings must be non-petroleum based and approved by OSHEM.
- E. Run piping concealed in areas with suspended ceilings, except as noted on the drawings.
- F. Sprinkler Pipe and Fittings: Provide in accordance with NFPA 13, except as modified herein. Steel piping shall be Schedule 40 per ASTM A53 for sizes less than 4 inches (101.6 mm) and Schedule 10 or 40 per ASTM A53 for sizes 4 inches (101.6 mm) and larger. ASTM A135, Schedule 40 piping may be used for pipe sizes less than 2 ½ inches (63.5 mm).
 1. Standard Installation:
 - a. Nominal pipe sizes 4 inches or larger: Schedule 10 or 40 Pipe meeting ASTM A-53, A-135 or A-795 with factory- or field-formed, roll-grooved
for Schedule 10 or 40 ends, or cut-grooved for Schedule 40 ends.
 - b. Nominal pipe sizes smaller than 4-inches: Schedule 40 Pipe meeting ASTM A-53, A-135, and A-795 with factory- or field-formed threaded ends.
 - c. For connections between 4 inch and larger pipes on risers, feed mains, cross-mains and drain lines, the requirements are as follows:
 - 1) Grooved pipe couplings and fittings for grooved pipe.
 - 2) Outlet coupling with screwed connection for grooved pipe.

- d. For connections from risers, feed mains, cross-mains, or drains to branch lines, the requirements are as follows:
 - 1) Welded outlet with screwed connection or threaded coupling or fittings.
- e. For connections to and between branch line pipes less than 4 inches the requirement is as follows:
 - 1) Threaded pipe couplings and fittings only.
- f. For connections between drain pipes requirement is as follows:
 - 1) Galvanized threaded or cut-grooved pipe couplings and fittings.
- 2. Pressure ratings: All fittings and gaskets shall meet or exceed the maximum working pressures present within the system.
- 3. Corrosion protection: All piping and hangers where exposed to the weather or installed in a corrosive atmosphere shall be protected against corrosion.
- 4. Pipe and Hanger Supports: Provide pipe supports, hangers, and clamps conforming to NFPA 13 and listed by UL or approved by FM. Provide galvanized supports, hangers, and clamps for all galvanized piping.
- 5. Joint Construction
 - a. Plain-end fittings with mechanical couplings, hole-cut mechanical threaded outlet fittings, hole-cut mechanical grooved outlet fittings, and hole-cut saddle clamp outlet fittings are not permitted for new systems. The above fitting types are only permitted on a case-by-case basis when approved by OSHEM.
 - b. Procedures for welding outlets shall be in strict conformance with the welding requirements of NFPA 13, including submission of welding certifications. Welding shall not be performed on-site.
 - c. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe with wall thickness less than Schedule 40.
 - d. Grooved Joints and Fittings: Assemble joints and fittings with listed coupling and gasket, lubricant, and bolts from the same manufacturer. Fittings and attached couplings shall be from the same manufacturer.
 - e. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved- end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.
 - f. If the galvanized coating on piping is found to be chipped or cracked upon

grooving of joint, two coats of liquid galvanizing material shall be applied to groove. The first coat shall be thoroughly dry prior to applying the second coat.

- G. Use of restriction orifices, reducing flanges, unions, and plain-end fittings is not permitted.
- H. Flanged fittings shall be used in lieu of unions with the exception of drain lines.
- I. The corrosion resistance ratio of pipe and fitting method shall not be less than 0.95.
- J. Pipe Hangers and Supports: Provide in accordance with NFPA 13.
- K. Identification Signs: Attach properly lettered approved metal or polycarbonate signs conforming to NFPA 13 to each valve and alarm device. Polycarbonate signs shall be red with engraved white letters. Signs at valves shall describe the sprinkler zone it controls and state that the valve is to remain open. Permanently affix design data nameplate to the riser of each system.
- L. Inspector's Test Connection: Provide test connections no higher than 6 ft (1.83 m) above the floor for each sprinkler system or portion of each sprinkler system equipped with an alarm device; locate at the [hydraulically most remote part of each system and at the] control valve/drain assembly. Provide combination drain valve and test connection. Discharge shall be readily visible from the inspector's test connection, either by direct observation of the discharge or through a sight glass. Discharge shall be piped to either an open building drain or to the outside. Drainage and test valves shall be bronze globe, angle, or gate valves.
- M. Drains: Provide drain piping to discharge at safe points outside the building or to sight cones attached to drains of adequate size to readily receive the full flow from each drain under maximum pressure. All drain piping and fittings are to be galvanized. Provide auxiliary drains as required by NFPA 13. Splash guards are to be provided where necessary at discharge outlets.
- N. Pipe Sleeves and Seals. Provide where conduit or piping passes through walls, floors, roofs and partitions. Provide clearance between exterior of piping and interior of sleeve in accordance with NFPA 13. See Section 078413 Penetration Firestopping, for sleeves and seals through fire-rated assemblies. Secure sleeves in proper position and location during construction. Provide sleeves of sufficient length to pass through the entire thickness of walls, floors, roofs, and partitions.
 - 1. Sleeves in Masonry and Concrete Walls, Floors, and Roofs: Provide ASTM A53, Schedule 40, zinc-coated steel pipe sleeves. Sleeves in floors shall project 4 inches (101.6 mm) above finished floors to prevent seepage.
 - 2. Sleeves in Partitions and Other than Masonry and Concrete Walls, Floors and Roofs: Sleeves shall be constructed from either zinc-coated schedule 40 steel pipe or zinc-

coated 26 gauge steel sheet.

- O. Escutcheon Plates: Provide one piece or split-hinge-type metal plates for piping passing through floors, walls, and ceilings in exposed and concealed areas. Provide chromium-plated or color-coordinated metal plates where pipe passes through finished ceilings. Securely anchor plates in proper position. Provide sprinkler escutcheon plates to match sprinkler head finish.

2.03 SPRINKLER HEADS

- A. Provide quick response sprinklers in offices and all other areas where their uses listed or approved. Heads located within the air streams of unit heaters or other heat-emitting equipment or skylights shall be selected for proper temperature rating.
- B. Where only a portion of the automatic sprinklers in a space are being replaced as part of a renovation, the response characteristics of the new sprinklers shall match those existing in the space.
- C. Heads shall have a nominal ½ inch (12.7 mm) orifice. Corrosion-resistant sprinkler heads shall be installed where they are exposed to the weather, moisture or corrosive vapors. Heads installed where they might receive mechanical injury or are less than 7 feet (2.13 m) above the floor level, shall be protected with approved guards in accordance with NFPA 13. Provide finish as indicated.

2.04 VALVES:

- A. Provide valves as required by NFPA 13. Valves shall be UL listed or FM approved for fire protection service.
- B. Gate Valves: Gate valves shall be the outside stem & yoke (OS&Y) type, and open by counterclockwise rotation. Gate valves installed higher than 7 feet (2.13 m) above the floor shall be provided with a chain drive or permanently mounted ladder. Provide a gate valve beneath each alarm valve in each riser when more than one alarm valve is supplied from the same water supply pipe. [For post indicator valves, provide operating nut located about 3 feet above finish grade. Gate valves for use with indicator posts shall conform to UL 262. Indicator posts shall conform to UL 789. Provide each indicator post with one coat of primer and two coats of red enamel paint.
- C. Check Valves: Check valves shall be clear-opening, swing-check type, with a bronze or stainless steel seat ring and an EPDM rubber clapper facing. Flanged check valves of sizes 4 inch (101.6 mm) and larger shall have flanged inspection and access cover plates.
- D. Butterfly valves: Butterfly valves are permitted only for pipe sizes of 4 inches (100 mm) and smaller.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Equipment, materials, installation, workmanship, examination, inspection and testing shall be in accordance with NFPA 13, except as modified herein. Install piping straight and true to bear evenly on hangers and supports. Install piping as close to the ceiling as possible, without interfering with other equipment and construction. Nipples shall be perpendicular to ceilings.
- B. Accurately align sprinkler heads in ceilings symmetrically with diffusers, and lights.
- B. Concealed head covers shall not be installed until ceiling construction is complete and an inspection to determine height compliance has been conducted by OSEM.
- C. Keep the interior and ends of all piping affected by Contractor's operations thoroughly clean of water and foreign matter by means of plugs or other approved methods. Inspect piping before placing into position. All pipe, fittings, and gaskets are to be cleaned of oil prior to installation.

3.02 FIELD CHANGES

- A. Do not make field changes in the piping layout, pipe sizes, or type of equipment, without the prior approval of the COTR.

3.03 CONNECTIONS TO EXISTING SPRINKLER SYSTEM

- A. Connection to the existing sprinkler system shall be done only after successfully testing new piping. Connections shall be as shown on the drawings. The COTR shall be notified at least 4 days prior to interruption of sprinkler protection.
- B. A schedule of any interruption of service shall be provided to the COTR and approval received before any service is interrupted. In no case shall the existing sprinkler system be shut off during periods other than normal Contractor construction hours.

3.04 FIELD PAINTING

- A. The Contractor shall remove all sprinkler heads which are painted and provide new, clean sprinkler heads of the proper type at his own expense. In addition to the primer, surfaces shall receive the following:

1. Above-Ground Piping Systems in Unfinished Areas: Unfinished areas are defined as attic spaces, mechanical equipment spaces, spaces above suspended ceilings, crawl spaces, pipe chases, and spaces where walls or ceilings are not painted or not constructed of a pre-finished material. ~~Provide primed surfaces with one coat of red enamel.~~ Provide 2 inch (50.8 mm) wide red enamel or self-adhering plastic bands on sprinkler piping, spaced at a maximum of 10 ft (3.05 m) intervals.
2. Above-Ground Piping Systems in Other Areas: Provide primed surfaces with two coats of paint to match adjacent surfaces, except valves and operating accessories shall receive one coat of red enamel. Provide piping with 2 inch (50.8 mm) wide red enamel bands or self-adhering red plastic bands spaced at a maximum of 10 ft (3.05 m) intervals. In finished areas such as offices, the red bands may be omitted.
3. All other coatings (e.g., zinc for galvanized pipe) shall be in compliance with NFPA 13.

3.05 FIELD TESTING AND FLUSHING

- A. All testing shall be scheduled with the COTR.
- B. At the discretion of the OSHM Fire Protection Engineer, an air pressure test may be required prior to filling the system with water. The test shall be conducted by raising the air pressure in the system to 40 psi (275.8 kPa) and allowing it to stand for 24 hours. There shall be no loss of air pressure greater than 1.5 psi (10.34 kPa) over the 24 hour period. Air pressure during this test shall be tracked via a graph over the 24 hour period by a pressure monitoring device or pressure monitoring gauge.
- C. Hydrostatic tests shall be conducted at the greater of 200 psi (1379 kPa) or the normal system pressure plus 50 psi (345 kPa) for a 2 hour period with no leakage or reduction in gage pressure. Hydrostatic test pressures shall not be maintained on the system overnight. Flush piping with potable water in accordance with NFPA 13.
- D. Preliminary Tests and Procedures: Test the alarms and other devices. Test the water flow alarms by flowing water through the inspector's test connection. [Prior to the hydrostatic test, perform an air test on the system.] [In areas where piping will be concealed by ceilings, walls, or other construction before the system is complete and ready for final testing, the preliminary hydrostatic test shall be conducted prior to piping being concealed. This test shall be witnessed by the COTR and the OSHM Fire Protection Engineer. When all tests and procedures are completed and corrections made, submit a signed and dated certificate, similar to that specified in NFPA 13, with a request for formal inspection and tests.
- E. Formal Inspection and Tests: At this time, all piping, sprinklers, and other system components shall be in-place and all adjustments to the system completed. The OSHM Fire Protection Engineer shall be notified by the COTR, shall witness all tests, and shall approve all systems before they are accepted. Submit a request for a formal inspection at least five

working days prior to the date the inspection is to take place. A competent representative of the sprinkler installer shall be present during testing and inspection. As-built drawings shall be on-site for the inspection. At this inspection, the system shall be hydrostatically tested. Any or all of the required tests shall be conducted by the Contractor at his own expense and additional tests made until it has been demonstrated that the systems comply with all contract requirements. The Contractor shall furnish all appliances, equipment, instruments, connecting devices and personnel for the tests. Any costs incurred by the SI for repeat tests, due to the failure of the Contractor to adequately demonstrate that the system complies with the contract requirements, shall be borne by the Contractor.

- F. CONNECTIONS TO EXISTING PIPING: During air and hydrostatic testing, the Contractor shall test new piping prior to connecting to the existing system. If the Contractor chooses to test the new piping while it is connected to existing piping or valves, the Contractor shall assume responsibility for all piping and equipment which is pressurized, as well as any damage caused by the failure of existing or new sprinkler systems. The SI accepts no responsibility for existing valves' performance to withstand hydrostatic pressure testing.

END OF SECTION 211313

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

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. Testing, adjusting, and balancing of equipment.
 - 2. Testing, adjusting, and balancing of existing HVAC systems and equipment.
 - 3. Sound tests.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. TAB: Testing, adjusting, and balancing.
- C. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- D. TDH: Total dynamic head.
- E. UFAD: Underfloor air distribution.

1.4 PREINSTALLATION MEETINGS

- A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
 - 1. Minimum Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Needs for coordination and cooperation of trades and subcontractors.
 - d. Proposed procedures for documentation and communication flow.

1.5 ACTION SUBMITTALS

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 60 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.
- C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.
- D. System Readiness Checklists: Within 60 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.7 QUALITY ASSURANCE

- A. TAB Specialists Qualifications, Certified by AABC:
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
 - 2. TAB Technician: Employee of the TAB specialist and certified by AABC.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."
- D. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.8 FIELD CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

3.2 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.
- F. Examine equipment performance data, including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine operating safety interlocks and controls on HVAC equipment.

- J. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers' startup is complete and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
 - 3. Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.
 - 4. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.5 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

- A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:
 - 1. Supply and Return grilles

3.6 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' Record drawings duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.

3.7 SOUND TESTS

- A. After systems are balanced and Substantial Completion, measure and record sound levels at five locations as designated by the Architect.
- B. Instrumentation:
 - 1. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.

2. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels, and measuring the equivalent continuous sound pressure level (L_{eq}).
3. The sound-testing meter must be capable of using one-third octave band filters to measure mid-frequencies from 31.5 Hz to 8000 Hz.
4. The accuracy of the sound-testing meter shall be plus or minus one decibel.

C. Test Procedures:

1. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
2. Equipment should be operating at design values.
3. Calibrate the sound-testing meter prior to taking measurements.
4. Use a microphone suitable for the type of noise levels measured that is compatible with meter. Provide a windshield for outside or in-duct measurements.
5. Record a set of background measurements in dBA and sound pressure levels in the eight unweighted octave bands 63 Hz to 8000 Hz (NC) with the equipment off.
6. Take sound readings in dBA and sound pressure levels in the eight unweighted octave bands 63 Hz to 8000 Hz (NC) with the equipment operating.
7. Take readings no closer than 36 inches from a wall or from the operating equipment and approximately 60 inches from the floor, with the meter held or mounted on a tripod.
8. For outdoor measurements, move sound-testing meter slowly and scan area that has the most exposure to noise source being tested. Use A-weighted scale for this type of reading.

D. Reporting:

1. Report shall record the following:
 - a. Location.
 - b. System tested.
 - c. dBA reading.
 - d. Sound pressure level in each octave band with equipment on and off.
2. Plot sound pressure levels on Noise Criteria (NC) worksheet with equipment on and off.

3.8 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan and equipment with fan(s).
2. Measure and record flows, temperatures, and pressures of each piece of equipment in each hydronic system. Compare the values to design or nameplate information, where information is available.
3. Measure motor voltage and amperage. Compare the values to motor nameplate information.
4. Check the refrigerant charge.
5. Check the condition of filters.
6. Check the condition of coils.
7. Check the operation of the drain pan and condensate-drain trap.
8. Check bearings and other lubricated parts for proper lubrication.

9. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. TAB After Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:
1. New filters are installed.
 2. Coils are clean and fins combed.
 3. Drain pans are clean.
 4. Fans are clean.
 5. Bearings and other parts are properly lubricated.
 6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
 3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
 4. Balance each air outlet.

3.9 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
1. Air Outlets and Inlets: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.10 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.

3.11 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
 - 3. Certify validity and accuracy of field data.

- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB specialist.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB supervisor who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents, including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 - 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 - 15. Test conditions for fans performance forms, including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Heating coil, dry-bulb conditions.
 - e. Face and bypass damper settings at coils.
 - f. Fan drive settings, including settings and percentage of maximum pitch diameter.
 - g. Variable-frequency controller settings for variable-air-volume systems.
 - h. Settings for pressure controller(s).

- i. Other system operating conditions that affect performance.
 16. Test conditions for pump performance forms, including the following:
 - a. Variable-frequency controller settings for variable-flow hydronic systems.
 - b. Settings for pressure controller(s).
 - c. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Air-Terminal-Device Reports:
1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft..
 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
- F. Instrument Calibration Reports:
1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.

- e. Dates of calibration.

3.12 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Architect.
- B. Architect shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.
- E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:
 - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
 - 2. If the second final inspection also fails, Owner may pursue others Contract options to complete TAB work.
- F. Prepare test and inspection reports.

3.13 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 233713.23 - REGISTERS AND GRILLES

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. Linear bar grilles.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples: For each exposed product and for each color and texture specified. Smallest size register and grille indicated.
- C. Samples for Initial Selection: For registers and grilles with factory-applied color finishes. Smallest size register and grille indicated.
- D. Samples for Verification: For registers and grilles, in manufacturer's standard sizes to verify color selected. Smallest size register and grille indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Duct access panels.
- B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 GRILLES

A. Linear Bar Grilles

1. Basis-of-Design Product: Subject to compliance with requirements, provide Price Industries Limited; LBP or comparable product by one of the following:
 - a. Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.
 - b. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
 - c. Nailor Industries Inc.
 - d. Titus; brand of Johnson Controls International plc, Global Products.
2. Material: Aluminum.
3. Finish: Factory primed, field painted, color selected by Architect.
4. Face Blade Arrangement: See plans.
5. Provide with integral volume damper.

2.2 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate registers and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install registers and grilles level and plumb.
- B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.23

SECTION 260010 - SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements generally applicable to all electrical Work on the Project, including but not limited to Work specified in Divisions 26, 27, and 28.

1.2 REFERENCES

A. Abbreviations and Acronyms for Electrical Terms and Units of Measure:

1. 8P8C: An 8-position 8-contact modular jack.
2. A: Ampere, unit of electrical current.
3. AC or ac: Alternating current.
4. AFCI: Arc-fault circuit interrupter.
5. AIC: Ampere interrupting capacity.
6. AL, Al, or ALUM: Aluminum.
7. ASD: Adjustable-speed drive.
8. ATS: Automatic transfer switch.
9. AWG: American wire gauge; see ASTM B258.
10. BAS: Building automation system.
11. BIL: Basic impulse insulation level.
12. BIM: Building information modeling.
13. BMS: Building management system.
14. CAD: Computer-aided design or drafting.
15. CATV: Community antenna television.
16. CB: Circuit breaker.
17. cd: Candela, the SI fundamental unit of luminous intensity.
18. CO/ALR: Copper-aluminum, revised.
19. COPS: Critical operations power system.
20. CU or Cu: Copper.
21. CU-AL or AL-CU: Copper-aluminum.
22. dB: Decibel, a unitless logarithmic ratio of two electrical, acoustical, or optical power values.
23. dB(A-weighted) or dB(A): Decibel acoustical sound pressure level with A-weighting applied in accordance with IEC 61672-1.
24. dB(adjusted) or dBa: Decibel weighted absolute noise power with respect to 3.16 pW (minus 85 dBm).
25. dBm: Decibel absolute power with respect to 1 mW.
26. DC or dc: Direct current.
27. DCOA: Designated critical operations area.
28. DDC: Direct digital control (HVAC).
29. EGC: Equipment grounding conductor.

30. ELV: Extra-low voltage.
31. EMF: Electromotive force.
32. EMI: Electromagnetic interference.
33. EMP: Electrical maintenance program (operation and maintenance); electromagnetic pulse (transient analysis).
34. EPS: Emergency power supply.
35. EPSS: Emergency power supply system.
36. ESS: Energy storage system.
37. EV: Electric vehicle.
38. EVPE: Electric vehicle power export equipment.
39. EVSE: Electric vehicle supply equipment.
40. FACU: Fire-alarm control unit.
41. fc: Footcandle, an internationally recognized unit of illuminance equal to one lumen per square foot or 10.76 lx. The simplified conversion 1 fc = 10 lx in the Specifications is common practice and considered adequate precision for building construction activities. When there are conflicts, lux is the primary unit; footcandle is specified for convenience.
42. FLC: Full-load current.
43. ft: Foot.
44. FTP: File transfer protocol.
45. GEC: Grounding electrode conductor.
46. GFCI: Ground-fault circuit interrupter.
47. GFPE: Ground-fault protection of equipment.
48. GND: Ground.
49. HACR: Heating, air conditioning, and refrigeration.
50. HDPE: High-density polyethylene.
51. HID: High-intensity discharge.
52. HP or hp: Horsepower.
53. HVAC: Heating, ventilating, and air conditioning.
54. Hz: Hertz.
55. IBT: Intersystem bonding termination.
56. ICT: Information and communications technology.
57. inch: Inch. To avoid confusion, the abbreviation "in." is not used.
58. I/O: Input/output.
59. IP: Ingress protection rating (enclosures); Internet protocol (communications).
60. IR: Infrared.
61. IS: Intrinsically safe.
62. IT&R: Inspecting, testing, and repair.
63. ITE: Information technology equipment.
64. kAIC: Kiloampere interrupting capacity.
65. kcmil or MCM: One thousand circular mils.
66. kV: Kilovolt.
67. kVA: Kilovolt-ampere.
68. kvar: Kilovolt-ampere reactive.
69. kW: Kilowatt.
70. kWh: Kilowatt-hour.
71. LAN: Local area network.
72. lb: Pound (weight).
73. lbf: Pound (force).
74. LCD: Liquid-crystal display.
75. LCDI: Leakage-current detector-interrupter.
76. LED: Light-emitting diode.

77. Li-ion: Lithium-ion.
78. lm: Lumen, the SI-derived unit of luminous flux.
79. LNG: Liquefied natural gas.
80. LP-Gas: Liquefied petroleum gas.
81. LRC: Locked-rotor current.
82. LV: Low voltage.
83. lx: Lux, the SI-derived unit of illuminance equal to one lumen per square meter.
84. m: Meter.
85. MCC: Motor-control center.
86. MDC: Modular data center.
87. MG set: Motor-generator set.
88. MIDI: Musical instrument digital interface.
89. MLO: Main lugs only.
90. MPEG-2: Abbreviation for the ISO/IEC Moving Picture Experts Group's standard for generic coding of moving pictures and associated audio information (ISO/IEC 13818) released in 1995 and used for most over-the-air and satellite broadcast digital television.
91. MPEG-4: Abbreviation for the ISO/IEC Moving Picture Experts Group's standard framework for coding of audio-visual objects (ISO/IEC 14496) released in 1999, with digital rights management and more advanced compression algorithms than MPEG-2.
92. MOV: Metal-oxide varistor.
93. MV: Medium voltage.
94. MVA: Megavolt-ampere.
95. mW: Milliwatt.
96. MW: Megawatt.
97. MWh: Megawatt-hour.
98. N.C.: Normally closed.
99. Ni-Cd: Nickel-cadmium.
100. Ni-MH: Nickel-metal hydride.
101. NIU: Network interface unit.
102. N.O.: Normally open.
103. NPT: National (American) standard pipe taper.
104. OCPD: Overcurrent protective device.
105. ONT: Optical network terminal.
106. PC: Personal computer.
107. PCS: Power conversion system.
108. PCU: Power-conditioning unit.
109. PF or pf: Power factor.
110. PHEV: Plug-in hybrid electric vehicle.
111. PLC: Programmable logic controller.
112. PLFA: Power-limited fire alarm.
113. PoE: Power over Ethernet.
114. POTS: Plain old telephone service. See "public switched telephone network" definition.
115. PSTN: Public switched telephone network.
116. PV: Photovoltaic.
117. PVC: Polyvinyl chloride.
118. pW: Picowatt.
119. RFI: (electrical) Radio-frequency interference; (contract) Request for interpretation.
120. RMS or rms: Root-mean-square.
121. RPM or rpm: Revolutions per minute.
122. SCADA: Supervisory control and data acquisition.
123. SCCR: Short-circuit current rating.

124. SCR: Silicon-controlled rectifier.
125. SPD: Surge protective device.
126. sq.: Square.
127. SWD: Switching duty.
128. TCP/IP: Transmission Control Protocol/Internet Protocol.
129. TEFC: Totally enclosed fan-cooled.
130. TR: Tamper resistant.
131. TVSS: Transient voltage surge suppressor.
132. UL: (standards) UL Standards & Engagement Inc.; (product categories) UL, LLC.
133. UL CCN: UL Category Control Number.
134. UPS: Uninterruptible power supply.
135. USB: Universal serial bus.
136. UV: Ultraviolet.
137. V: Volt, unit of electromotive force.
138. V(ac): Volt, alternating current.
139. V(dc): Volt, direct current.
140. VA: Volt-ampere, unit of complex electrical power.
141. VAR: Volt-ampere reactive, unit of reactive electrical power.
142. VFC: Variable-frequency controller.
143. VOM: Volt-ohm-multimeter.
144. VoIP: Voice over Internet Protocol.
145. VPN: Virtual private network.
146. VRLA: Valve regulated lead acid; also called "sealed lead acid (SLA)" or "valve regulated sealed lead acid."
147. W: Watt, unit of real electrical power.
148. WAN: Wide area network.
149. Wh: Watt-hour, unit of electrical energy usage.
150. WPT: Wireless power transfer.
151. WPTE: Wireless power transfer equipment.
152. WR: Weather resistant.

B. Abbreviations and Acronyms for Electrical Raceway Types:

1. EMT: Electrical metallic tubing.
2. EMT-A: Aluminum electrical metallic tubing.
3. EMT-S: Steel electrical metallic tubing.
4. EMT-SS: Stainless steel electrical metallic tubing.
5. ENT: Electrical nonmetallic tubing.
6. EPEC: Electrical HDPE underground conduit (thin wall).
7. EPEC-A: Type A electrical HDPE underground conduit.
8. EPEC-B: Type B electrical HDPE underground conduit.
9. ERMC: Electrical rigid metal conduit.
10. ERMC-A: Aluminum electrical rigid metal conduit.
11. ERMC-S: Steel electrical rigid metal conduit.
12. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
13. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
14. ERMC-SS: Stainless steel electrical rigid metal conduit.
15. FMC: Flexible metal conduit.
16. FMC-A: Aluminum flexible metal conduit.
17. FMC-S: Steel flexible metal conduit.
18. FMT: Steel flexible metallic tubing.

19. FNMC: Flexible nonmetallic conduit. See "LFNC."
20. HDPE: HDPE underground conduit (thick wall).
21. HDPE-40: Schedule 40 HDPE underground conduit.
22. HDPE-80: Schedule 80 HDPE underground conduit.
23. IMC: Steel electrical intermediate metal conduit.
24. LFMC: Liquidtight flexible metal conduit.
25. LFMC-A: Aluminum liquidtight flexible metal conduit.
26. LFMC-S: Steel liquidtight flexible metal conduit.
27. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
28. LFNC: Liquidtight flexible nonmetallic conduit.
29. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
30. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
31. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
32. PVC: Rigid PVC conduit.
33. PVC-40: Schedule 40 rigid PVC conduit.
34. PVC-80: Schedule 80 rigid PVC Conduit.
35. PVC-A: Type A rigid PVC concrete-encased conduit.
36. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.
37. RGS: See ERMC-S-G.
38. RMC: See ERMC.
39. RTRC: Reinforced thermosetting resin conduit.
40. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
41. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
42. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
43. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
44. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

C. Abbreviations and Acronyms for Electrical Single-Conductor and Multiple-Conductor Cable Types:

1. AC: Armored cable.
2. CATV: Coaxial general-purpose cable.
3. CATVP: Coaxial plenum cable.
4. CATVR: Coaxial riser cable.
5. CI: Circuit integrity cable.
6. CL2: Class 2 cable.
7. CL2P: Class 2 plenum cable.
8. CL2R: Class 2 riser cable.
9. CL2X: Class 2 cable, limited use.
10. CL3: Class 3 cable.
11. CL3P: Class 3 plenum cable.
12. CL3R: Class 3 riser cable.
13. CL3X: Class 3 cable, limited use.
14. CM: Communications general-purpose cable.
15. CMG: Communications general-purpose cable.
16. CMP: Communications plenum cable.
17. CMR: Communications riser cable.
18. CMUC: Under-carpet communications wire and cable.

19. CMX: Communications cable, limited use.
20. DG: Distributed generation cable.
21. FC: Flat cable.
22. FCC: Flat conductor cable.
23. FPL: Power-limited fire-alarm cable.
24. FPLP: Power-limited fire-alarm plenum cable.
25. FPLR: Power-limited fire-alarm riser cable.
26. IGS: Integrated gas spacer cable.
27. ITC: Instrumentation tray cable.
28. ITC-ER: Instrumentation tray cable, exposed run.
29. MC: Metal-clad cable.
30. MC-HL: Metal-clad cable, hazardous location.
31. MI: Mineral-insulated, metal-sheathed cable.
32. MTW: (machine tool wiring) Moisture-, heat-, and oil-resistant thermoplastic cable.
33. MV: Medium-voltage cable.
34. NM: Nonmetallic sheathed cable.
35. NMC: Nonmetallic sheathed cable with corrosion-resistant nonmetallic jacket.
36. NMS: Nonmetallic sheathed cable with signaling, data, and communications conductors, plus power or control conductors.
37. NPLF: Non-power-limited fire-alarm circuit cable.
38. NPLFP: Non-power-limited fire-alarm circuit cable for environmental air spaces.
39. NPLFR: Non-power-limited fire-alarm circuit riser cable.
40. NUCC: Nonmetallic underground HDPE conduit with conductors.
41. OFC: Conductive optical fiber general-purpose cable.
42. OFCG: Conductive optical fiber general-purpose cable.
43. OFCP: Conductive optical fiber plenum cable.
44. OFCR: Conductive optical fiber riser cable.
45. OFN: Nonconductive optical fiber general-purpose cable.
46. OFNG: Nonconductive optical fiber general-purpose cable.
47. OFNP: Nonconductive optical fiber plenum cable.
48. OFNR: Nonconductive optical fiber riser cable.
49. P: Marine shipboard cable.
50. PLTC: Power-limited tray cable.
51. PLTC-ER: Power-limited tray cable, exposed run.
52. PV: Photovoltaic cable.
53. RHH: (high heat) Thermoset rubber, heat-resistant cable.
54. RHW: Thermoset rubber, moisture-resistant cable.
55. SA: Silicone rubber cable.
56. SE: Service-entrance cable.
57. SER: Service-entrance cable, round.
58. SEU: Service-entrance cable, flat.
59. SIS: Thermoset cable for switchboard and switchgear wiring.
60. TBS: Thermoplastic cable with outer braid.
61. TC: Tray cable.
62. TC-ER: Tray cable, exposed run.
63. TC-ER-HL: Tray cable, exposed run, hazardous location.
64. THW: Thermoplastic, heat- and moisture-resistant cable.
65. THHN: Thermoplastic, heat-resistant cable with nylon jacket outer sheath.
66. THHW: Thermoplastic, heat- and moisture-resistant cable.
67. THWN: Thermoplastic, moisture- and heat-resistant cable with nylon jacket outer sheath.
68. TW: Thermoplastic, moisture-resistant cable.

69. UF: Underground feeder and branch-circuit cable.
70. USE: Underground service-entrance cable.
71. XHH: Cross-linked polyethylene, heat-resistant cable.
72. XHHW: Cross-linked polyethylene, heat- and moisture-resistant cable.

D. Abbreviations and Acronyms for Electrical Flexible Cord Types:

1. SEO: 600 V extra-hard-usage, hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp locations.
2. SEOW: 600 V extra-hard-usage, hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp or wet locations.
3. SEOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp locations.
4. SEOOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp or wet locations.
5. SJEO: 300 V hard-usage, junior hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp locations.
6. SJEOW: 300 V hard-usage, junior hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp or wet locations.
7. SJEOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp locations.
8. SJEOOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp or wet locations.
9. SJO: 300 V hard-usage, junior hard-service cord with thermoset insulation and oil-resistant thermoset outer cover for damp locations.
10. SJOW: 300 V hard-usage, junior hard-service cord with thermoset insulation and oil-resistant thermoset outer cover for damp or wet locations.
11. SJOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer cover for damp locations.
12. SJOOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer cover for damp or wet locations.
13. SJTO: 300 V hard-usage, junior hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer cover for damp locations.
14. SJTOW: 300 V hard-usage, junior hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer cover for damp or wet locations.
15. SJTOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer cover for damp locations.
16. SJTOOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer cover for damp or wet locations.
17. SO: 600 V extra-hard-usage, hard-service cord with thermoset insulation and oil-resistant thermoset outer covering for damp locations.
18. SOW: 600 V extra-hard-usage, hard-service cord with thermoset insulation and oil-resistant thermoset outer covering for damp or wet locations.
19. SOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer covering for damp locations.

20. SOOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer covering for damp or wet locations.
21. STO: 600 V extra-hard-usage, hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer covering for damp locations.
22. STOW: 600 V extra-hard-usage, hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer covering for damp or wet locations.
23. STOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer covering for damp locations.
24. STOOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer covering for damp or wet locations.

E. Definitions:

1. 8-Position 8-Contact (8P8C) Modular Jack: An unkeyed jack with up to eight contacts commonly used to terminate twisted pair and multiconductor Ethernet cable. Also called a "TIA-1096 miniature 8-position series jack" (8PSJ), or an "IEC 8877 8-pole jack."
 - a. Be careful when suppliers use "RJ45" generically. Obsolete RJ45 jacks used for analog telephone cables have rejection keys. 8P8C jacks used for digital telephone cables and Ethernet cables do not have rejection keys.
2. Basic Impulse Insulation Level (BIL): Reference insulation level expressed in impulse crest voltage with a standard wave not longer than 1.5 times 50 microseconds and 1.5 times 40 microseconds.
3. Cable: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "cable" is (1) a conductor with insulation, or a stranded conductor with or without insulation (single-conductor cable); or (2) a combination of conductors insulated from one another (multiple-conductor cable).
4. Communications Jack: A fixed connecting device designed for insertion of a communications cable plug.
5. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.
6. Conductor: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "conductor" is (1) a wire or combination of wires not insulated from one another, suitable for carrying an electric current; (2) (National Electrical Safety Code) a material, usually in the form of wire, cable, or bar, suitable for carrying an electric current; or (3) (general) a substance or body that allows a current of electricity to pass continuously along it.
7. Conduit: A structure containing one or more duct raceways.
8. Designated Seismic System: An architectural, electrical, or mechanical system and its components for which the component importance factor is greater than 1.0 when determined in accordance with Section 018123 "Facility Seismic and Wind Criteria."
9. Direct Buried: Installed underground without encasement in concrete or other protective material.
10. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.
11. Duct Raceway: A single enclosed raceway for conductors or cable.
12. Electrical Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

13. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:
- a. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
 - b. Concrete Box: A box intended for use in poured concrete.
 - c. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
 - d. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.
 - e. Cover Plate: A cover designed for protecting wiring devices installed in flush-mounted device boxes while permitting their safe operation; also called a faceplate or wallplate.
 - f. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.
 - g. Device Box: A box with provisions for mounting a wiring device directly to the box.
 - h. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.
 - i. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.
 - j. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.
 - k. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the entrance of scrub water at the floor level.
 - l. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
 - m. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.
 - n. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.
 - o. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.
 - p. Raised-Floor Box: A floor box intended for use in raised floors.
 - q. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.
 - r. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.

- s. Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.
 - t. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.
 - u. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.
14. Emergency Systems: Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction that are designed to ensure continuity of lighting, electrical power, or both, to designated areas and equipment in the event of failure of the normal supply for safety to human life.
 15. Essential Electrical Systems: (healthcare facilities) Those systems designed to ensure continuity of electrical power to designated areas and functions of a healthcare facility during disruption of normal power sources, and also to minimize disruption within the internal wiring system.
 16. Fault Limited: Providing or being served by a source of electrical power that is limited to not more than 100 W when tested in accordance with UL 62368-1.
 - a. The term "fault limited" is intended to encompass most Class 1, 2, and 3 power-limited sources complying with Article 725 of NFPA 70; Class ES1 and ES2 electrical energy sources that are Class PS1 electrical power sources (e.g., USB); and Class ES3 electrical energy sources that are Class PS1 and PS2 electrical power sources (e.g., PoE). See UL 62368-1 for discussion of classes of electrical energy sources and classes of electrical power sources.
 17. High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.
 18. Jacket: A continuous nonmetallic outer covering for conductors or cables.
 19. Luminaire: A complete lighting unit consisting of a light source such as a lamp, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light.
 20. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the Energy Independence and Security Act (EISA) of 2007.
 21. Multi-Outlet Assembly: A type of surface, flush, or freestanding raceway designed to hold conductors, receptacles, and switches, assembled in the field or at the factory.
 22. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein. Also called "single-line diagram."
 23. Plenum: A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
 24. Protective Device: A device that senses when an abnormal current flow, abnormal voltage potential, or other abnormal electrical waveform exists and then disconnects the affected portion of the circuit from the system. Common protective devices include fuses, circuit breakers, relays, ground-fault circuit interrupters, and arc-fault circuit interrupters.

25. Public Switched Telephone Network (PSTN): Analog telephone technology that uses twisted pair cables from a telephone-provider central office for the transmission medium. "PSTN" refers to the telephone network; "POTS" refers to the individual subscriber line.
26. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.
27. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.
28. Sheath: A continuous metallic covering for conductors or cables.
29. UL Category Control Number (CCN): An alphabetic or alphanumeric code used to identify product categories covered by UL's Listing, Classification, and Recognition Services.
30. Voice over Internet Protocol (VoIP): Digital telephone packet technology that uses the internet for its transmission medium.
31. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:
 - a. Control Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is supplied from a battery or other Class 2 or Class 3 power-limited source.
 - b. Line Voltage: (1) (controls) Designed to operate using the supplied low-voltage power without transformation. (2) (transmission lines, transformers, SPDs) The line-to-line voltage of the supplying power system.
 - c. Extra-Low Voltage (ELV): Not having electromotive force between any two conductors, or between a single conductor and ground, exceeding 30 V(ac rms), 42 V(ac peak), or 60 V(dc).
 - d. Low Voltage (LV): Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 30 V but not exceeding 1000 V.
 - e. Medium Voltage (MV): Having electromotive force between any two conductors, or between a single conductor and ground, that is rated about 1 kV but not exceeding 69 kV.
 - f. High Voltage: (1) (circuits) Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 69 kV but not exceeding 230 kV. (2) (safety) Having sufficient electromotive force to inflict bodily harm or injury.
32. Wire: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "wire" is a slender rod or filament of drawn metal. A group of small wires used as a single wire is properly called a "stranded wire." A wire or stranded wire covered with insulation is properly called an "insulated wire" or a "single-conductor cable." Nevertheless, when the context indicates that the wire is insulated, the term "wire" will be understood to include the insulation.

1.3 COORDINATION

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions:
 1. Notify Owner no fewer than seven days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without Owner's written permission.
 3. Coordinate interruption with systems impacted by outage including, but not limited to, the following:
 - a. Exercising generators.
 - b. Emergency lighting.
 - c. Elevators.
 - d. Fire-alarm systems.
 4. Arrange to provide temporary emergency and standby electrical **power**]so facility may remain occupied during the outage in accordance with requirements specified in Section 015000 "Temporary Facilities and Controls." Coordinate power requirements with Owner.
- B. Interruption of Existing Security System: Do not interrupt security system to facilities occupied by Owner or others unless permitted under the following conditions:
1. Notify Owner no fewer than seven days in advance of proposed interruption of security system.
 2. Do not proceed with interruption of security system without Owner's written permission.
- C. Interruption of Existing Fire-Alarm System: Do not interrupt fire-alarm system to facilities occupied by Owner or others unless permitted under the following conditions:
1. Notify Owner no fewer than seven days in advance of proposed interruption of fire-alarm system.
 2. Do not proceed with interruption of fire-alarm system without Owner's written permission.

1.4 SEQUENCING

- A. Conduct and submit results of power system studies before submitting product data and Shop Drawings for electrical equipment.

1.5 INFORMATIONAL SUBMITTALS

- A. Electrical Installation Schedule: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for electrical installation Work to Owner and Architect including, but not limited to, milestone dates for the following activities:
1. Submission of power system studies.
 2. Submission of specified coordination drawings.
 3. Submission of action submittals specified in Division 26.
 4. Orders placed for major electrical equipment.
 5. Arrival of major electrical equipment on-site.
 6. Preinstallation meetings specified in Division 26.
 7. Utility service outages.
 8. Utility service inspection and activation.

9. Mockup reviews.
 10. Closing of walls and ceilings containing electrical Work.
 11. System startup, testing, and commissioning activities for major electrical equipment.
 12. System startup, testing, and commissioning activities for emergency lighting.
 13. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
 14. Pouring of concrete housekeeping pads for electrical equipment and testing of concrete samples.
 15. Requests for special inspections.
 16. Requests for inspections by authorities having jurisdiction.
- B. Installation Schedule for Security, Fire-Alarm, and Other Life-Safety Systems: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for installation of security, fire-alarm, and the other life-safety Work to Owner and Architect including, but not limited to, milestone dates for the following activities:
1. Submission of specified coordination drawings.
 2. Submission of action submittals specified in Division 28.
 3. Orders placed for major equipment.
 4. Arrival of major equipment on-site.
 5. Preinstallation meetings specified in Division 28.
 6. Security and fire-alarm system outages.
 7. Security and fire-alarm system inspection and activation.
 8. Mockup reviews.
 9. Closing of walls and ceilings containing the security and fire-alarm Work.
 10. System startup, testing, and commissioning activities for security and fire-alarm equipment.
 11. System startup, testing, and commissioning activities for fire-alarm interfaces with the Work specified in other divisions.
 12. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
 13. Requests for special inspections.
 14. Requests for inspections by authorities having jurisdiction.
- C. Qualification Statements:
1. For qualified regional manufacturer.
 2. For electrical professional engineer.
 3. For lighting professional engineer.
 4. For EPM specialist.
 5. For welder.
 6. For ERMC-S-PVC raceway Installer.
 7. For electrical power monitoring Installer.
 8. For theatrical lighting Installer.
 9. For low-voltage electrical testing agency and on-site electrical testing supervisor.
 10. For luminaire photometric testing laboratory.
 11. For lighting testing and inspecting agency.
 12. For security design professional.
 13. For life-safety professional engineer.

14. For fire-alarm cable Installer.
15. For security testing agency and on-site security testing supervisor.
16. For fire-alarm testing agency and on-site fire-alarm testing supervisor.

1.6 CLOSEOUT SUBMITTALS

A. Facility EMP Binders:

1. Complete Set: On approved online or cloud solution USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement.
2. Volumes 2 and 8: Reproducible hardcopy on archival quality, 28 lb (105 GSM), acid-free, bond paper.

B. Software and Firmware Operational Documentation: Provide software and firmware operational documentation, including the following:

1. Software operating and upgrade manuals.
2. Names, versions, and website addresses for locations of installed software.
3. Device address list.
4. Printout of software application and graphic screens.
5. Testing and adjusting of panic and emergency power features.
6. For lighting controls, include the following:
 - a. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
 - b. Operation of adjustable zone controls.

C. Software:

1. Program Software Backup: Provide username and password for approved online or cloud solution USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement.

1.7 SUBSTITUTION LIMITATIONS FOR ELECTRICAL EQUIPMENT

A. Substitution requests for electrical equipment will be entertained under the following conditions:

1. Substitution requests may be submitted for consideration prior to the Electrical Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with the Project performance requirements while significantly increasing value for Owner throughout life of facility.
2. Substitution requests may be submitted for consideration concurrently with submission of power system study reports when those reports indicate that substitution is necessary for safety of maintenance personnel and facility occupants.
3. Contractor is responsible for sequencing and scheduling power system studies and electrical equipment procurement. After the Electrical Preconstruction Conference, insufficient lead time for electrical equipment delivery will not be considered a valid reason for substitution.

1.8 SUBSTITUTION LIMITATIONS FOR ELECTRONIC SAFETY AND SECURITY EQUIPMENT

- A. Substitution requests for electronic safety and security equipment will be entertained under the following conditions:
1. Substitution requests may be submitted for consideration prior to the Electronic Safety and Security Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with the Project performance requirements while significantly increasing value for Owner throughout life of facility.
 2. Contractor is responsible for sequencing and scheduling equipment procurement. After the Electronic Safety and Security Preconstruction Conference, insufficient lead time for equipment delivery will not be considered a valid reason for substitution.

1.9 FACILITY ELECTRICAL MAINTENANCE PROGRAM (EMP) BINDERS

- A. Description: Set of binders containing operation and maintenance data for facility's electrical equipment that was compiled during analysis of installed electrical Work for Facility EMP development.
- B. Applicable Standards:
1. Regulatory Requirements: Comply with requirements in NFPA 70B.
 2. General Characteristics:
 - a. Volume 1 - Introduction:
 - 1) Summarize how Facility EMP analysis was performed, how data were collected, and how volumes are organized.
 - 2) Describe Facility EMP and provide recommended policies and procedures for implementing the program and keeping it current.
 - 3) Provide place for Owner to identify contact information for employees responsible for implementing and maintaining Facility EMP.
 - b. Volume 2 - Facility Safety, Hazards Awareness, and Emergency Procedures:
 - 1) Include training requirements for employees and contractors.
 - 2) Include list of known facility hazards impacting IT&R activities.
 - 3) Include approval and permitting procedures for IT&R activities.
 - 4) Include incident emergency response procedures.
 - 5) Include emergency shutdown procedures.
 - 6) Include electrical disaster recovery procedures.
 - 7) Include procedures for investigating the following incidents:
 - a) Electrical safety incidents.
 - b) Equipment malfunctions.
 - c) Unintended operations or alarms.
 - d) Operation of protective devices.
 - c. Volume 4 - Facility Diagrams and Schedules:

- 1) Include single-line diagrams.
 - 2) Include grounding and bonding diagrams.
 - 3) Include essential wiring diagrams.
 - 4) Include system automation diagrams (SCADA, BMS, lighting, HVAC, etc.).
 - 5) Include records of switchgear, switchboard, and panelboard schedules.
 - 6) Include time-current curves for overcurrent protective devices.
 - 7) Include list of load-current and overload-relay heaters with related motor nameplate data.
- d. Volume 5 - Inventory of Facility Equipment Using Electrical Power:
- 1) Include simplified floor plans showing equipment locations.
 - 2) Identify critical equipment (electrical or otherwise).
 - 3) Include identifying designations and nameplate data.
 - 4) Include warranty and maintenance contract information.
- e. Volume 6 - Inventory of Facility Tools, Supplies, and Personnel Protective Equipment:
- 1) Include schedules of maintenance material items recommended to be stored at facility.
 - 2) Include list of lamp types and photoelectric relays used in facility with ANSI and manufacturers' codes.
 - 3) Include calibration and servicing data for each item.
- f. Volume 7 - Inspection, Testing, and Repair (IT&R) Plan:
- 1) Include tables showing frequency of activities for each item.
 - 2) Include annual schedule with activities mapped to specific days of the year.
 - 3) Include exterior pole inspection and repair procedures.
- g. Volume 9 - Spare Parts List:
- 1) Include list of all parts required to perform IT&R procedures.
 - 2) Identify quantities of which parts are recommended to be stored on-site.
 - 3) Include source contact information and budget cost for each item.
- h. Volume 10 - Construction Project Closeout Record Documentation:
- 1) Include records of power system studies and photometric studies.
 - 2) Include records of risk assessment studies.
 - 3) Include records of electrical system startup and commissioning activities.
 - 4) Include records of baseline inspections and tests.
 - 5) Include records of baseline infrared photographs with normal light photographs showing the location, direction, angle, and conditions necessary for reproducing each infrared photograph.
 - 6) Include records of baseline settings for adjustable equipment and devices.

PART 2 - EXECUTION

2.1 DEVELOPMENT OF FACILITY ELECTRICAL MAINTENANCE PROGRAM (EMP)

- A. Facility EMP must be developed by qualified EMP specialist.
- B. Conduct Facility EMP analysis in accordance with NFPA 70B requirements.
 - 1. Renovation Projects:
 - a. Obtain copies of existing operation and maintenance data and existing Facility EMP information from Owner.
 - b. Facility EMP analysis should identify existing equipment that does not have available operation and maintenance data, and should explain Owner's risks because this equipment is not included in Facility EMP.
 - c. Data for existing equipment outside scope of the Project may be inserted in Facility EMP Binders without analysis.
 - d. Data for existing equipment impacted by scope of the Project should be analyzed and documented similar to the Project's new equipment data as much as possible.
- C. Compile operation and maintenance data from Facility EMP analysis and submit **updated** Facility EMP Binders.

2.2 INSTALLATION OF ELECTRICAL WORK

- A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' written instructions, comply with NFPA 70 and NECA NEIS 1 for installation of electrical Work on the Project. Consult Architect for resolution of conflicting requirements.

2.3 ACTIVITIES

- A. Training:
 - 1. Train SI's maintenance personnel on the following topics:
 - a. How to implement updated facility EMP.
 - b. How to operate and program lighting control system.
 - 2. Allow SI to record training sessions.

END OF SECTION 260010

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper building wire.
2. Aluminum building wire.
3. Nonmetallic underground conduit with conductors, Type NUCC.
4. Metal-clad cable, Type MC.
5. Tray cable, Type TC.
6. Fire-alarm wire and cable.
7. Connectors and splices.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Copper building wire.
2. Metal-clad cable, Type MC.
3. Tray cable, Type TC.
4. Fire-alarm wire and cable.
5. Connectors and splices.

B. Product Schedule: Indicate type, use, location, and termination locations.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 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. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- C. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- D. Conductor Insulation:
 - 1. Type NM. Comply with UL 83 and UL 719.
 - 2. Type RHH and Type RHW-2. Comply with UL 44.
 - 3. Type USE-2 and Type SE. Comply with UL 854.
 - 4. Type TC-ER. Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
 - 5. Type THHN and Type THWN-2. Comply with UL 83.
 - 6. Type THW and Type THW-2. Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
 - 7. Type UF. Comply with UL 83 and UL 493.
 - 8. Type XHHW-2. Comply with UL 44.

2.2 METAL-CLAD CABLE, TYPE MC

- A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
- B. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. Comply with UL 1569.
 - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- C. Circuits:
 - 1. Single circuit.
 - 2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.
- D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- E. Ground Conductor: Insulated.
- F. Conductor Insulation:
 - 1. Type TFN/THHN/THWN-2. Comply with UL 83.
 - 2. Type XHHW-2. Comply with UL 44.

- G. Armor: **Steel**, interlocked.
- H. Jacket: PVC applied over armor.

2.3 TRAY CABLE, TYPE TC

- A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in a nonmetallic jacket.
- B. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. Comply with UL 1277.
 - 3. Comply with ICEA S-73-532/NEMA WC 57 for Type TC cables used for control, thermocouple extension, and instrumentation.
 - 4. Comply with ICEA S-95-658/NEMA WC 70 for Type TC cables used for power distribution.
 - 5. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- C. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- D. Ground Conductor: Insulated.
- E. Conductor Insulation: Type XHHW-2. Comply with UL 44.
- F. Shield: None.

2.4 FIRE-ALARM WIRE AND CABLE

- A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- B. Signaling Line Circuits: Twisted, shielded pair, No. 18 AWG.
 - 1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.
- C. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
 - 1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
 - 3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with red identifier stripe, NRTL listed for fire-alarm and cable tray installation, plenum rated.

2.5 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. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
 - 1. Material: Copper.
 - 2. Type: One hole with standard barrels.
 - 3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders:
 - 1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits:
 - 1. Copper:
 - a. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 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 in Cable Tray: Metal-clad cable, Type MC.
- D. Exposed Branch Circuits, Including in Crawlspace: 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.
- F. Branch Circuits in Cable Tray: Metal-clad cable, Type MC.

- 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.

3.3 INSTALLATION, GENERAL

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points in accordance with Section 260533.13 "Conduits 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."
- G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.
- H. Minimum wire size will be #12AWG, THHN-2, THWN. All conductors will be copper.
- I. Branch circuits rated 20 Amperes, 120V, and exceed 75 circuit feet from panelboard will be #10AWG. Branch circuits rated 20 Amperes, 277V, and exceed 150 circuit feet from panelboard will be #10AWG.

3.4 INSTALLATION OF FIRE-ALARM WIRE AND CABLE

- A. Comply with NFPA 72.
- B. Wiring Method: Install wiring in metal pathway according to Section 270528.29 "Hangers and Supports for Communications Systems."
 - 1. Install plenum cable in environmental airspaces, including plenum ceilings.
 - 2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system must be installed in a dedicated pathway system.
 - a. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
 - 3. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is permitted.
 - 4. Signaling Line Circuits: Power-limited fire-alarm cables must not be installed in the same cable or pathway as signaling line circuits.

- C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.
- E. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.
- F. Wiring to Remote Alarm Transmitting Device: 1 inch (25 mm) conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 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 **6 inch (150 mm)** of slack.
- D. Comply with requirements in Section 284621.13 "Conventional Fire-Alarm Systems" for connecting, terminating, and identifying wires and cables.

3.6 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.

3.7 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."

3.8 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."

3.9 FIELD QUALITY CONTROL

- A. Tests and Inspections:

- 1. 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.

- B. Cables will be considered defective if they do not pass tests and inspections.

- C. 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 260519

SECTION 260526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding and bonding conductors.
2. Grounding and bonding clamps.
3. Grounding and bonding bushings.
4. Grounding and bonding hubs.
5. Grounding and bonding connectors.
6. Intersystem bonding bridge grounding connectors.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
2. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.
 - a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
 - b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
 - c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

B. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

1.4 QUALIFICATIONS

- A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.
- B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems, evaluate tests, test equipment, test results, and power system performance, recommend actions to maintain or improve system performance, and lead multi-team projects.
- C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - 1. On-site electrical testing supervisors must possess active NICET EPT Technician III certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 GROUNDING AND BONDING CONDUCTORS

- A. Equipment Grounding Conductor:
 - 1. Standard Features: 600 V, THHN/THWN-2 or THWN-2, copper wire or cable, green color, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Isolated Equipment Grounding Conductor:
 - 1. Standard Features: 600 V, THHN/THWN-2 or THWN-2, copper wire or cable, green color with one or more yellow stripes, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. ASTM - Bare Copper Grounding and Bonding Conductor:
 - 1. Standard Features: Complying with one or more of the following:
 - a. Soft or Annealed Copper Wire: ASTM B3.
 - b. Concentric-Lay Stranded Copper Conductor: ASTM B8.
 - c. Tin-Coated Soft or Annealed Copper Wire: ASTM B33.
 - d. 19-Wire Combination Unilay-Stranded Copper Conductor: ASTM B787/B787M.
- D. UL KDER - Armored Grounding Wire:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 2. Standard Features: Single corrosion-resistant copper, aluminum, or copper-clad aluminum conductor within helically formed steel armor.
 - a.
- E. UL KDSH - Protector Grounding Conductor:
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
 2. Standard Features:
 - a. Conductors intended to be used for grounding primary protector or metallic members of cable sheath in accordance with Chapters 7 and 8 of NFPA 70.
 - b. Color: **Light olive gray or green.**

2.3 GROUNDING AND BONDING CLAMPS

- A. Description: Clamps suitable for attachment of grounding and bonding conductors to grounding electrodes, pipes, tubing, and rebar. Grounding and bonding clamps specified in this article are also suitable for use with communications applications.
- B. UL KDER - Beam Grounding and Bonding Clamp :
1. Source Limitations: Obtain products from single manufacturer.
 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
 3. Standard Features: Mechanical-type, terminal, ground wire access from four directions; with dual, tin-plated or silicon bronze bolts.
- C. UL KDER - Exothermically Welded Connection:
1. Source Limitations: Obtain products from single manufacturer.

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
3. Standard Features: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING AND BONDING BUSHINGS

- A. Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures, and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure. Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.
- B. UL KDER - Bonding Bushing:
 1. Source Limitations: Obtain products from single manufacturer.
 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 3. Standard Features: Threaded bushing with insulated throat.
- C. UL KDER - Grounding Bushing:
 1. Source Limitations: Obtain products from single manufacturer.
 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 3. Standard Features: Threaded bushing with insulated throat and mechanical-type wire terminal.

2.5 GROUNDING AND BONDING HUBS

- A. UL KDER - Grounding and Bonding Hub:
 1. Source Limitations: Obtain products from single manufacturer.
 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

3. Standard Features: Insulated, gasketed, watertight hub with mechanical-type wire terminal.

2.6 GROUNDING AND BONDING CONNECTORS

- A. UL KDER - Crimped Lug Pressure-Type Grounding and Bonding Busbar Terminal:
 1. Source Limitations: Obtain products from single manufacturer.
 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
 3. Standard Features: Cast silicon bronze, solderless compression-type wire terminals; with long barrel and two holes spaced on 5/8 or 1 inch (16 or 25 mm) centers for two-bolt connection to busbar.
- B. UL KDER - Split-Bolt Service-Post Pressure-Type Grounding and Bonding Busbar Terminal :
 1. Source Limitations: Obtain products from single manufacturer.
 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
 3. Standard Features: Bolts that surround cable and bond to cable under compression when nut is tightened after assembly is screwed into busbar opening.
- C. UL KDER - Crimped Pressure-Type Grounding and Bonding Cable Connector:
 1. Source Limitations: Obtain products from single manufacturer.
 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
 3. Standard Features: Crimp-and-compress connectors that bond to conductor when connector is compressed around conductor.
 - a. Copper, C and H shaped.
- D. UL KDER - Split-Bolt Pressure-Type Grounding and Bonding Cable Connector:
 1. Source Limitations: Obtain products from single manufacturer.

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
 3. Standard Features: Bolts that surround cable and bond to cable under compression when nut is tightened.
 - a. Copper.
- E. UL KDER - Signal Reference Grid Grounding and Bonding Connector:
1. Source Limitations: Obtain products from single manufacturer.
 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
 3. Standard Features: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

2.7 INTERSYSTEM BONDING BRIDGE GROUNDING CONNECTORS

- A. Description: Devices that provide means for connecting communications systems grounding and bonding conductors at service equipment or at disconnecting means for buildings or structures.
- B. UL KDSH - One-Piece Intersystem Bonding Bridge Grounding Connector:
 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
 2. Standard Features: Zinc-alloy one-piece construction; six terminating points; gangable.
- C. UL KDSH - Two-Piece Intersystem Bonding Bridge Grounding Connector:
 1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

2. Standard Features: Zinc-alloy body and polycarbonate cover; four terminating points.

PART 3 - EXECUTION

3.1 SELECTION OF GROUNDING AND BONDING PRODUCTS

A. Grounding and Bonding Conductors:

1. Provide solid conductor for 8 AWG and smaller, and stranded conductors for 6 AWG and larger unless otherwise indicated.
2. Custom-Length Insulated Equipment Bonding Jumpers: 6 AWG, 19-strand, Type THHN.
3. Bonding Cable: 28 kcmil, 14 strands of 17 AWG conductor, 1/4 inch (6 mm) in diameter.
4. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.
5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch (41 mm) wide and 1/16 inch (1.6 mm) thick.
6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Underground Grounding Conductors: Install bare tinned-copper conductor, 2/0 AWG minimum.

B. Grounding and Bonding Connectors:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 INSTALLATION OF GROUNDING AND BONDING

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Work in ITE Rooms: NFPA 75.
7. Work in Health Care Facilities: NFPA 99 and Article 517 of NFPA 70.
8. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
9. Work in Confined Spaces: NFPA 350.
10. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
11. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest

point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

12. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Grounding and Bonding Conductors:

- a. 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.

2. Grounding and Bonding Connectors: 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.

- a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
- b. Make connections with clean, bare metal at points of contact.
- c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
- d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
- e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- f. 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 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 disconnect-type connection is required, use bolted clamp.

- g. Grounding and Bonding for Piping:

- 1) Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use bolted clamp connector or bolt lug-type connector to pipe flange by using one of lug bolts of flange. Where dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
- 2) Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with bolted connector.
- 3) Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

- h. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
 - i. Grounding for Steel Building Structure: Install driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 ft (18 m) apart.
3. Equipment Grounding and Bonding:
- a. Install insulated equipment grounding conductors with feeders and branch circuits.
 - b. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1) Feeders and branch circuits.
 - 2) Lighting circuits.
 - 3) Receptacle circuits.
 - 4) Flexible raceway runs.
 - c. 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.
 - d. Isolated Grounding Receptacle Circuits: Install insulated equipment grounding conductor connected to receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.

3.3 FIELD QUALITY CONTROL FOR GROUNDING AND BONDING

- A. Administrant for Electrical Power Tests and Inspections:
- 1. Contractor will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
 - 2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
 - 3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
 - 4. Administer and perform tests and inspections.
- B. Field tests and inspections must be witnessed by authorities having jurisdiction.
- C. 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 calibrated torque wrench in accordance with manufacturer's published instructions.
 3. Test completed grounding system at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal. Make tests at ground rods before conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method in accordance with IEEE Std 81.
 - c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.
- D. Nonconforming Work:
1. Grounding system will be considered defective if it does not pass tests and inspections.
 2. Remove and replace defective components and retest.
- E. Collect, assemble, and submit test and inspection reports.
1. Report measured ground resistances that exceed the following values:
 - a. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 Ω .
 - b. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 Ω .
 - c. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 Ω .

3.4 PROTECTION

- A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260526

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Boxes, enclosures, and cabinets.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for firestopping at conduit and box entrances.

1.3 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:

1. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. GRC: Comply with ANSI C80.1 and UL 6.
3. IMC: Comply with ANSI C80.6 and UL 1242.
4. EMT: Comply with ANSI C80.3 and UL 797.

B. Metal Fittings:

1. Comply with NEMA FB 1 and UL 514B.
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. Fittings, General: Listed and labeled for type of conduit, location, and use.
4. Fittings for EMT:
 - a. Material: Steel.

- b. Type: compression.
- 5. 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.
- C. Joint Compound for IMC, GRC, or ARC: 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.

2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. Nonmetallic Conduit:
 - 1. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- B. Nonmetallic Fittings:
 - 1. Fittings, General: Listed and labeled for type of conduit, location, and use.
 - 2. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
 - 3. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, **ferrous alloy**, Type FD, with gasketed cover.
- D. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.
- 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 by 2-1/8 inches by 2-1/8 inches deep (100 mm by 60 mm by 60 mm deep)
- H. Gangable boxes are allowed.

- I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 for indoor dry locations 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.

2.4 SLEEVE AND SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Advance Products & Systems, Inc.
 2. Calpico, Inc.
 3. Metraflex Co.
 4. Pipeline Seal and Insulator, Inc.
- C. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
 1. Sealing Elements: EPDM (Ethylene-propylene-diene terpolymer rubber) or NBR (Acrylonitrile-butadiene rubber) interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 2. Pressure Plates: Plastic or carbon steel or stainless steel. Include two for each sealing element.
 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating or stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.
- D. Grout: Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Indoors: Apply raceway products as specified below unless otherwise indicated:
 1. Exposed, Not Subject to Severe Physical Damage: EMT
 2. Exposed and Subject to Severe Physical Damage: GRC or IMC. Raceway locations include the following:
 - a. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - b. Mechanical rooms.
 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.

4. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- B. Minimum Raceway Size: 3/4-inch (21-mm) trade size.
 1. Indoor areas: 3/4-inch trade size minimum
- C. Raceway Fittings: Compatible with raceways and suitable for use and location.
 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. EMT: Use compression fittings. Comply with NEMA FB 2.10.
- D. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

- A. Comply with requirements in Section 260529 "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 "explosion-relief" walls or rotating equipment.
- D. Do not fasten conduits onto the bottom side of a metal deck roof.
- E. Keep raceways at least 6 inches (150 mm) 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 (300 mm) 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. The following are exceptions for concealing conduits:
 1. Where specifically noted or indicated on the drawings
 2. Electrical rooms with surface mounted panels
 3. Mechanical rooms

4. In open ceilings with exposed structure
- K. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- M. 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 (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- N. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- O. 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.
- P. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- Q. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- R. 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 conduits pass from warm to cold locations, such as boundaries of refrigerated spaces. or from conditioned spaces to non-conditioned spaces or to exterior structures.
 2. Where otherwise required by NFPA 70.
- S. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- T. Expansion-Joint Fittings:
 1. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 2. 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.
- U. 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.
- V. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat

surface for a raintight connection between box and cover plate or supported equipment and box.

- W. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- X. Locate boxes so that cover or plate will not span different building finishes.
- Y. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- Z. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- AA. Existing Building Surfaces: In finished rooms where an existing wall or ceiling remains in place, cut and patch to match the surrounding finishes as required to conceal all raceways. Coordinate work directly with contractor responsible ceiling, walls, and partition finishes.
- BB. Conceal raceways within existing finished ceilings, walls, and partitions, unless otherwise indicated on the drawings or as follows:
 - 1. Existing Hollow Walls (such as stud walls, hollow masonry walls, or other wall types with internal voids or vertical cavities):
 - a. Outlet Boxes: If possible, use existing openings in wall, provided the opening is positioned within 24-inches of the location shown on plan for the new outlet. Otherwise, cut and patch wall as needed to install box flush.
 - b. Conduit: If possible, fish MC cabling down within the existing wall cavity. Otherwise, saw-cut and patch wall as needed to conceal conduit within the wall. Finish wall to match original.
 - c. This Contractor shall visit the facility to review existing conditions and determine means and methods of installation prior to bidding.
 - d. Where specifically identified on the drawings, use surface-mounted boxes and surface-mounted conduit painted to match the surrounding finishes.
 - 2. Existing Solid Walls (such as precast panels or filled masonry walls):
 - a. Use surface-mounted boxes and surface-mounted conduit painted to match the surrounding finishes.
 - 3. Existing Floors: Cut and patch existing floors as needed to accommodate new installations. Coordinate all such work with the general contractor prior to bidding.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 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 260544
SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAY AND CABLING

PART 1 - GENERAL**1.1 SUMMARY****A. Section Includes:**

1. Round sleeves.
2. Rectangular sleeves.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.
6. Pourable sealants.
7. Foam sealants.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

PART 2 - PRODUCTS**2.1 ROUND SLEEVES****A. Round, Galvanized-Steel, Sheet Metal Sleeves:**

1. General Characteristics: Galvanized-steel sheet; thickness not less than 0.0239 inch (0.6 mm); round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

B. Round, Schedule 40 Steel Sheet metal Sleeves.**2.2 RECTANGULAR SLEEVES****A. Rectangular, Galvanized-Steel, Sheet Metal Sleeves:**

1. General Characteristics:
 - a. Material: Galvanized sheet steel.
 - b. Minimum Metal Thickness:

- 1) For sleeve cross-section rectangle perimeter less than 50 inch (1270 mm) and with no side larger than 16 inch (400 mm), thickness must be 0.052 inch (1.3 mm).
- 2) For sleeve cross-section rectangle perimeter not less than 50 inch (1270 mm) or with one or more sides larger than 16 inch (400 mm), thickness must be 0.138 inch (3.5 mm).

2.3 GROUT

- A. General Characteristics: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
 2. Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

2.4 POURABLE SEALANTS

- A. Performance Criteria:
1. General Characteristics: Single-component, neutral-curing elastomeric sealants of grade indicated below.
 - a. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2.5 FOAM SEALANTS

- A. Performance Criteria:
1. General Characteristics: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:
1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.

SECTION 260800
COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electrical equipment connected to Normal electrical systems, including the following:
 - a. Transformers.
 - b. Distribution and branch-circuit panelboards.
 - c. Grounding systems.
2. Electrical equipment connected to Essential electrical systems that provide an alternative source of power in the absence of power from the Normal electrical system, including the following:
 - a. Distribution and branch-circuit panelboards.
 - b. Grounding systems.
3. Controls and instrumentation, including the following:
 - a. Lighting control systems.
 - b. Fire-alarm systems.
4. Systems testing and verification, including Normal and Essential electrical systems.

B. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
2. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

- A. BoD: Basis-of-Design Document, as defined in Section 019113 "General Commissioning Requirements."
- B. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."
- C. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."
- D. OPR: Owner's Project Requirements, as defined in Section 019113 "General Commissioning Requirements."
- E. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they mean "as-built" systems, assemblies, subsystems, equipment, and components.

1.3 INFORMATIONAL SUBMITTALS

- A. Construction Checklists by Contractor: Include the following and comply with requirements in Section 019113 "General Commissioning Requirements" for construction checklists:
1. Instrumentation and control for lighting control systems.
 2. Low-voltage power cables.
 3. Control voltage power cables.
 4. Electrical feeders and branch circuits.
 5. Protective relays.
 6. Metering devices.
 7. Molded-case circuit breakers.
 8. Low-voltage power circuit breakers.
 9. Grounding systems.
 10. Ground-fault protection systems.
 11. Panelboards.
 12. Receptacles and devices.

1.4 QUALITY ASSURANCE

- A. Testing Equipment and Instrumentation Quality and Calibration: For test equipment and instrumentation required to perform electrical Cx work, perform the following:
1. Submit test equipment and instrumentation list. For each equipment or instrument, identify the following:
 - a. Equipment/instrument identification number.
 - b. Planned Cx application or use.
 - c. Manufacturer, make, model, and serial number.
 - d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
 2. Test equipment and instrumentation must meet the following criteria:
 - a. Capable of testing and measuring performance within the specified acceptance criteria.
 - b. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
 - c. Be maintained in good repair and operating condition throughout duration of use on Project.
 - d. Be recalibrated/repared if dropped or damaged in any way since last calibrated.
- B. Proprietary Test Instrumentation and Tools:
1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, perform the following:

- a. Submit proprietary instrumentation and tools list. For each instrument or tool, identify the following:
 - 1) Instrument or tool identification number.
 - 2) Equipment schedule designation of equipment for which the instrument or tool is required.
 - 3) Manufacturer, make, model, and serial number.
 - 4) Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.
- b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.
- c. Electrical proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 CONSTRUCTION CHECKLISTS

- A. Prepare detailed construction checklists for electrical systems, subsystems, equipment, and components. Complete and submit construction checklists.

3.2 GENERAL TESTING REQUIREMENTS

- A. Certify that electrical systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating according to the Contract Documents and approved Shop Drawings and submittals.
- B. Certify that electrical instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved Shop Drawings and submittals, and that pretest set points have been recorded.
- C. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (for example, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- D. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.
- E. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and response according to acceptance criteria.
- F. Construction Checklists: Prepare and submit detailed construction checklists for electrical systems, subsystems, equipment, and components.

1. Contributors to development of construction checklists must include, but are not limited to, the following:
 - a. Electrical systems and equipment installers.
 - b. Electrical instrumentation and controls installers.
 - G. Perform tests using design conditions, whenever possible.
 1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA, and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
 2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
 3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.
 - H. If tests cannot be completed because of a deficiency outside the scope of the electrical system, document the deficiency and report it to Owner. After deficiencies are resolved, reschedule tests.
 - I. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.
 - J. Coordinate schedule with, and perform Cx activities at the direction of the CxA.
 - K. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance tests requirements specified in Sections specifying electrical systems and equipment.
 - L. Provide qualified testing and inspecting agency personnel in accordance with Section 260010 "Supplemental Requirements for Electrical," instrumentation, tools, and equipment to complete and document the following:
 1. Performance tests.
 2. Demonstration of a sample of performance tests.
 3. Cx tests.
 4. Cx test demonstrations.
- ### 3.3 Cx TESTS FOR ELECTRICAL SYSTEMS
- A. Verification of Normal Electrical System Operation:
 1. Prerequisites: Acceptance of results for construction checklists for Division 26 electrical components associated with Normal electrical system.
 2. Equipment and Systems to Be Tested: Division 26 electrical equipment.
 3. Test Purpose: Verify operation of Normal electrical system.
 4. Test Conditions: Energize components of Normal electrical system, one at a time.
 5. Acceptance Criteria: Proper operation of Normal electrical system over a 24 hour period.

- B. Verification of Essential Electrical System Operation:
 - 1. Prerequisites:
 - a. Acceptance of results for construction checklists for Division 26 electrical components associated with Essential electrical system.
 - b. Completion of "Verification of Normal Electrical System Operation" tests.
 - 2. Equipment and Systems to Be Tested: Division 26 electrical equipment.
 - 3. Test Purpose: Verify operation of Essential electrical system.
 - 4. Test Conditions:
 - a. Energize components of Normal electrical system.
 - b. Simulate a failure of Normal electrical system.
 - 5. Acceptance Criteria: Transfer of power from Normal to Essential electrical system within OPR.
- C. Verification of Control and Instrumentation:
 - 1. Prerequisites: Acceptance of results for construction checklists.
 - a. Section 260913 "Electrical Power Monitoring and Control."
 - b. Section 260926 "Lighting Control Panelboards."
 - c. Section 260943.23 "Relay-Based Lighting Controls."
- D. Test Purpose: Verify operation of control and monitoring systems for Normal and Essential electrical systems.
- E. Test Conditions:
 - 1. Energize components of Normal electrical system.
 - 2. Test operation of equipment.
- F. Acceptance Criteria: Operation of equipment according to OPR.

END OF SECTION 260800

**SECTION 260923
LIGHTING CONTROL SYSTEMS AND DEVICES**

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Digital lighting management systems.
2. Lighting control relay panels.
3. Conductors and cables.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 262726 "Wiring Devices" for line-voltage dimmers, non-networkable wall- switch occupancy sensors, and manual light switches.

1.2 SUBMITTALS

A. Product Data and Shop Drawings:

1. Submit manufacturer's technical product data for each type of lighting control system and its components.
2. Manufacturer's warranty documentation specifically for this contract.
3. Detailed point to point wiring diagrams.
4. Wiring schedules.
5. Typical wiring diagrams for each component.
6. System diagrams showing contactor panels, number and type of switches and sensors, low-voltage switches, and building energy management system computer.
7. Provide sequence of operations for each space type in a format suitable for programming requirements of the specific system and meeting the intent of the sequence of operation provided by the architect/engineer.

B. Closeout Documentation:

1. Field quality-control test reports.
2. Record drawings reflecting as-built information, including floor plans, wiring diagrams, equipment and wiring schedules, and room schedules.
3. Operation and Maintenance Manuals:
 - a. Manufacturer's technical product data and maintenance data.
 - b. Manufacturer's warranty documentation.

4. Software and Firmware Operational Documentation:
 - a. Software service agreement.
 - b. Software operating and upgrade manuals.

1.3 WARRANTY

- A. Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, software, and devices that fail to perform as specified within extended warranty period.
 1. Special Extended Warranty Period: Shall exceed four (4) years starting from the date of Substantial Completion.
 - a. If the manufacturer's warranty commences upon the date materials are delivered, then the manufacturer's warranty period shall be at least five (5) years to meet the requirement stated above.

1.4 SOFTWARE AND FIRMWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion provide a 5-year software service agreement to the Owner.
- B. Software and Firmware Upgrades:
 1. At Substantial Completion, update software and firmware to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Verify upgrading software includes operating system and new or revised licenses for using software.
 2. Upgrade Notice: Provide a 30-day notice to Owner to allow scheduling and access to the system and to allow Owner upgrade to computer equipment if necessary.
 3. Upgrade Reports: Prepare written report after each update, documenting upgrades installed.

1.5 QUALITY ASSURANCE

- A. Codes and Standards:
 1. NFPA 70, National Electrical Code (NEC).
 2. UL 508, Standard for Industrial Control Panels.
 3. UL 916, Standard for Energy Management Equipment.
 4. UL 917, Standard for Clock Operated Switches.
 5. UL 924, Standard for Emergency Lighting and Power Equipment.
 6. 47 CFR, Subparts A and B, for Class A digital devices.
- B. Comply with NEC, NEMA, and FCC emission requirements for Class A applications. Comply with applicable city, county, and state codes and ordinances.

- C. Certification: Manufacturer shall certify that products will meet product specifications and local energy codes. If any additional equipment is required to meet coverage patterns and local energy codes, provide additional equipment at no additional cost to the Owner.
- D. Manufacturer's Field Service and Commissioning: Engage a factory-authorized service representative to inspect, test, and adjust sensors and associated system components, and to guarantee sensor performance.
- E. Ceiling-mount devices and wall-mount devices installed above 6 ft. shall be flat and/or textured white. Wall-mount devices installed 42-inch above floor shall match device color and wall plate specified in Section 262726 "Wiring Devices".

PART 2 - PRODUCTS

2.1 DIGITAL LIGHTING MANAGEMENT SYSTEMS

- A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Intelligent Lighting Controls, Inc.
 - 2. Acuity Brands, Inc. (nLight).
 - 3. Crestron Electronics, Inc. (Green Light).
 - 4. Eaton / Greengate / Cooper Lighting Controls, Inc.
 - 5. Hubbell Building Automation.
- C. System Architecture: System shall have an architecture that is based upon a network backbone for manual, remote or time-based operation utilizing lighting control relay panels.
- D. System Description and Operation
 - 1. Intelligent lighting control devices shall consist of panel based operable relays with integrated 0-10V dimming capability associated with each relay, and remote manual switch and dimming stations.
 - 2. Lighting control zone shall be capable of automatically configuring itself for default operation without any startup labor required.
 - 3. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.
 - 4. All switching and dimming for a specific lighting zone shall take place within the centralized relay panel. Specific applications that require distributed or remote switching shall be capable of being accommodated.
 - 5. System shall have a primary network control "gateway" device capable of accessing and controlling connected system devices and linking into an Ethernet LAN.
 - 6. System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control profiles.

7. Individual lighting zones shall be capable of being segmented into several channels of occupancy, photoelectric sensor, and switch functionality for more advanced configurations and sequences of operation.
 8. System shall be capable of operating a lighting control zone according to several sequences of operation. Note operating modes should be utilized only in manners consistent with local energy codes.
 - a. Auto-on / auto-off (via occupancy sensors)
 - b. Manual-on / auto-off
 - c. Auto-to-override on
 - d. Manual-to-override on
 - e. Auto on /predictive off
 - f. Multi-level on (multiple lighting levels per manual button press)
 9. System programming shall be done in the following fashion:
 - a. For completely networked systems, system programming and control adjustments can be done via software from a single point in the network.
 - b. For stand-alone systems, programming shall be done by hand-held remote control or by software app via standard wireless protocol such as Wi-Fi or Bluetooth.
 10. Control software shall enable integration with a BAS via BACNET IP.
 11. Interface with Building Automation System (BAS)
 - a. Provide hardware and software interface to enable the DDC system for HVAC to monitor and control lighting functions. System shall provide the ability to directly interface with the building automation system via Bacnet IP. Coordination with Division 23 is critical prior to acquisition of material
 - b. All time scheduling shall reside on the BAS system.
- E. System Cabling: Intelligent devices shall be connected to the lighting control relay. Communications and Class 2 low voltage power shall be provided to each intelligent device via standard low-voltage UTP Category 5 cabling with RJ45 connectors. RJ45 adapters may be used to allow standard analog sensors to be used.
1. All cabling for intra-room connectivity of control devices shall be pre-manufactured and provided by controls manufacturer.
 2. Intelligent lighting control devices shall communicate digitally and possess at least two RJ45 connectors.
 3. Devices within a lighting control zone shall be connected using low-voltage cabling, in a daisy-chain fashion, and in any order.
 4. System shall provide the option of having pre-terminated plenum rated Category 5 cabling supplied with hardware.
 5. Field prepared cables may be used in the following situations:
 - a. Long cable lengths (ex. Between relay panels) or other cabling where the standard available lengths would provide a significant excess or shortage of cable.
 - b. Instances, if any, where cabling will have to be pulled in conduit, and pulling a terminated cable will add excessive difficulty and/or risk damaging the cable.

F. Management Software

1. Every device parameter (e.g., sensor time delay and photoelectric sensor set-point) shall be available and configurable remotely from the software.
2. The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current occupancy sensor status, remaining occupancy time delay(s), current photoelectric sensor reading, current photoelectric sensor inhibiting state, photoelectric sensor transitions time remaining, current dim level, device temperature, and device relay state(s).
3. The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom labels, and parent network device.
4. A printable network inventory report shall be available via the software.
5. A printable report detailing all system profiles shall be available via the software.
6. Software shall require all users to login with a username and password.
7. Software shall provide at least three permission levels for users.
8. All sensitive stored information and privileged communication by the software shall be encrypted.
9. All device firmware and system software updates must be available for automatic download and installation via the internet.
10. Software shall be capable of managing systems interconnected via a WAN (wide area network).

G. Applications:

1. Furnish and install digital lighting management systems in each room, space, or area as indicated on the Drawings, or wherever the following applies:
 - a. Wherever lighting is controlled by a low-voltage multi-button control station (as opposed to a line-voltage switch).
 - b. Wherever the Energy Code requires the lighting to be turned on via manual operation only and/or a room where the lighting is controlled by one or more vacancy sensors.

H. Low-Voltage Momentary-Contact Programmable Pushbutton Lighting Control Stations

1. Provide programmable 1-, 2-, 3-, 4-, 5-, 6-, 7-, or 8-button control stations corresponding to each application indicated on the lighting plans and lighting control diagrams, including power enable/disable and dimming controls. "Buttons" may also be provided via an optional touchscreen interface device.
2. Include an LED status indicator integral to each programmable button or a touchscreen status indicator.
3. Include factory-produced symbols etched into each programmable button to indicate its general function, such as on/off, up, down (dimming), etc. Refer to details on the drawings. If an optional touchscreen interface device is provided, labeling and symbols may be programmed on the display.
4. Multiple control stations located within in the same vicinity shall be mounted in a common wall-box with a multi-gang faceplate.
5. Initial Programming: Upon energizing luminaires, each control station shall be programmed to provide basic manual on/off functions (so that no luminaire remains on or off 24/7 without manual control). This initial programming shall be provided prior to the

manufacturer's factory-authorized technician performing their official system programming, configuration, startup, and system commissioning services.

6. Communications and Class 2 low-voltage power connection between device and LRC shall be standard low-voltage UTP Category 5 cabling with RJ45 connectors.

I. Presence Sensors (Indoor Occupancy and Vacancy Sensors)

1. Refer to indoor occupancy/vacancy sensors below for types and performance specifications.
 - a. Auxiliary Contacts: Provide each zone of lighting control with an additional auxiliary contact/relay, form C, dry contacts, rated for and compatible with the building automation system (BAS). Contact may be provided integral to either the presence sensor or the LRC. Coordinate with the Division 23 contractor.
2. Presence sensors shall function as vacancy sensors by default, which requires the occupant to manually turn-on the lights.
 - a. Typical exceptions, unless noted otherwise: Toilet rooms, restrooms, locker rooms, and other special locations as indicated on the drawings.
3. Communications and Class 2 low-voltage power connection between device and lighting relay panel shall be standard low-voltage UTP Category 5 cabling with RJ45 connectors.

J. Intelligent lighting control relay panels to be integrated with digital management lighting systems.

1. Refer to Lighting Control Relay Panels below for additional specifications.
2. Panel shall supply current limited low voltage power to other networked devices connected via Category 5 cabling.
3. Dimming channels shall be assignable to control zones as required via the control software.
4. Dimming channels shall be configurable to respond to manual raise/lower wall switch control stations, preset scenes, or daylight-harvesting photoelectric sensors.
5. Switched receptacles shall be controlled via relay panels. Each circuit shall have a dedicated relay to allow for programming flexibility and to limit the effect of a faulty relay or receptacle.

K. Network Communication Bridges

1. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to Control Gateway or central head end.
2. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a low voltage cabled connection.
3. Device shall be careful of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power.

2.2 SWITCHBOX-MOUNTED OCCUPANCY AND VACANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Basis of Design: Watt Stopper / Legrand.
 2. Acuity Brands, Inc. (Sensor Switch).
 3. Crestron Electronics, Inc.
 4. Eaton / Greengate / Cooper Lighting Controls, Inc.
 5. Encelium / Osram Sylvania, Inc.
 6. Hubbell Building Automation.
 7. Intelligent Lighting Controls, Inc.
 8. Leviton Manufacturing Co.
- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox using hardwired connection.
1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
 2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time-delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 3. Vacancy Sensor Operation: Same as occupancy sensor operation, except lights turn on only when occupant manually operates the switch.
 4. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
 5. Switch Rating: Not less than 15 A consisting of LED lighting load.
- C. Features and Performance Characteristics:
1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft.
 2. Sensing Technology: PIR, unless indicated otherwise on drawings.
 3. Switch Type: Single-pole, single switch-leg, unless indicated otherwise on drawings.
 4. Field-selectable automatic "on" or manual "on".
 5. Capable of controlling load in three-way application.
 6. Voltage: Match the circuit voltage.
 7. Concealed, field-adjustable, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes. Initial setting shall be 5 minutes.
 8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.3 LIGHTING CONTROL RELAY PANELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Intelligent Lighting Controls, Inc.
 2. Acuity Brands, Inc. (nLight).
 3. Crestron Electronics, Inc. (Green Light).

4. Eaton / Greengate / Cooper Lighting Controls, Inc.
 5. Hubbell Building Automation.
- B. Description: Networkable and standalone capability using mechanically latched switching relays to control lighting and appliances, with 0-10V dimming protocol and with physical barriers separating emergency and normal branch lighting circuits.
1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
 2. Control Panel: A single enclosure with incoming lighting branch circuits, control circuits, switching relays, 0-10V dimming outputs and on-board timing and control unit. A vertical barrier separating branch circuits from control wiring.
 - a. Panels shall be configured with the quantity of relays and 0 - 10 volt dimming channels as indicated.
 - b. Provide capacity for 8, 16, 24, 32, or 48 relays in each panel as indicated.
 - c. Provide the quantity of relays indicated in the schedule, including spares.
 - d. Panel shall incorporate normally closed latching relays capable of switching 120/277 V(ac) loads.
 - e. Relays shall be rated to switch up to a continuous 30A LED load at 277 VAC.
 - f. Relays shall have a minimum Short Circuit Current Rating (SCCR) of 14,000A. Higher ratings shall be provided where indicated.
 - g. Control must be three-wire, 24 V(ac) and/or via digital control network cabling.
 - h. Panel shall power itself from an integrated 120/277 VAC supply.
 - i. Panel shall provide auxiliary low-voltage device power connected wired directly to a dedicated connection-terminals.
 3. Sequence of Operations: Input signal from field-mounted manual switches, or digital signal sources, must open or close one or more lighting control relays in the lighting control panels. Any combination of inputs must be programmable to any number of control relays.
 4. Control Unit: Contain the power supply and electronic control for operating and monitoring individual relays.
 - a. Nonvolatile memory must retain all setup configurations. After a power failure, the controller must automatically reboot and return to normal system operation, including accurate time of day and date.
 - b. 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, control-voltage inputs, field-installed occupancy sensors, and photoelectric sensors.
 - c. Software: Menu-driven data entry. Online and offline programming and editing. Provide for entry of the room or space designation for the load side of each relay. Monitor and control all relays, showing actual relay state and the name of the automatic actuating control, if any
 - d. Operator Interface: Integral alphanumeric keypad and digital display, and intuitive drop-down menus to assist in programming. Log and display relay on-time. Connect relays to one or more time and sequencing schemes.

- e. Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.
 - f. Sequencing control must operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.
 - g. Override control must 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.
 - h. Override control "blink warning" must warn occupants approximately five minutes before actuating the off sequence.
5. Enclosure: Comply with NEMA 250. Refer to drawings for specific applications.

C. Interface with Building Automation System (BAS)

1. Provide hardware interface to enable the DDC system for HVAC to monitor and control lighting contactors.
2. Monitoring and Control Points: Refer to schedule on drawings.
3. System shall provide the ability to directly interface with the building automation system via Bacnet IP. Connection capability can be made via hardware or software interface. Coordination with Division 23 is critical prior to acquisition of material.
4. All time scheduling shall reside on the BAS system.
5. The lighting control system shall translate and forward lighting relay and other select control commands from BAS system to networked control devices.

2.4 EQUIPMENT ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
1. Dry and Clean Indoor Locations: NEMA 250, Type 1.

2.5 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: 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 Cable: Multiconductor cable with stranded-copper conductors. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 DELEGATED DESIGN

- A. This contract shall include the complete design and application of lighting control systems. Determine all system components, cabling specifications, and programming required for

complete and functional operation. If necessary, obtain clarification from Architect/Engineer prior to bidding regarding intent of contract documents.

- B. Provide additional quantities and placement of sensors as needed to achieve coverage of area served at actual mounting heights.
- C. The wiring methods indicated on the electrical drawings are to indicate design intent only. Approved manufacturer controls products may have different driver and sensor requirements and different wiring methods than what is shown on the electrical drawings. Contractors are required to familiarize themselves with all required wiring, additional part and pieces, required installation labor, etc. to provide for a complete installed system that meets the intent and functionality of the specified system.
- D. The Contractor shall provide as part of the shop drawing submittals, complete lighting drawings including all wiring, equipment, equipment locations, etc. for the submitted system.
- E. All costs shall be included in the bid for a complete operational system that meets the specified and designed system.
- F. Control Intent: Control Intent includes, but is not limited to the following:
 - 1. Defaults and initial calibration settings for such items as time delay, sensitivity, fade rates, etc.
 - 2. Initial sensor and switching zones
 - 3. Initial time switch settings

3.2 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION OF SENSORS

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies, as applicable.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.

3.4 INSTALLATION OF WIRING

- A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 3/4 inch.

- B. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.
- C. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.
- E. Include a neutral conductor connected to every "switch point", such as wall-switch occupancy sensors, in accordance with NEC 404.2(C).
- F. Identify components and power and control wiring in accordance with Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- G. Label switches and contactors with a unique designation as specified or as indicated on the drawings.

3.5 PROGRAMMING AND DEVICE SETTINGS

- A. Manufacturer's Field Service and Commissioning: Engage a factory-authorized service representative to program, configure, test, and adjust components associated with each lighting control system and each lighting control device.
- B. Initial Programming: Upon energizing luminaires associated with lighting control stations, each control station shall be programmed to provide basic manual on/off functions (so that no luminaire remains on or off 24/7 without manual control). This initial programming shall be provided prior to the manufacturer's factory-authorized technician performing their official system programming, configuration, startup, and system commissioning services.
- C. Occupancy and Vacancy Sensor Settings and Adjustments
 - 1. Position, aim, and adjust sensors to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
 - 2. Lights shall turn on immediately after the light-switch, dimmer, or control station is engaged.
 - 3. Lights must stay on while presence is detected.
 - 4. Lights shall turn off after a preset time-delay commencing from the last moment presence was detected (corresponding to vacancy). The initial time-delay off setting shall be 10 minutes. Coordinate final settings directly with the Owner.
 - 5. Provide a walk-through with the Owner's representative to confirm final settings and overall functionality.
- D. Initial device settings and any additional information shown on the drawings shall be finalized at the pre-submittal meeting.

- E. Continuous Dimming Daylight-Harvesting, Field Settings, and Adjustments
 - 1. Sensor operation shall be based upon a closed-loop control method. Placement, installation, and programming of device shall be in accordance with the manufacturer's installation instructions and recommendations.
 - 2. During nighttime hours (no daylight), with all lights turned on and turned up 100%, determine the average lighting level (foot-candles) at 30-inches AFF throughout the space. This value shall be regarded as the design level.
 - 3. Program and calibrate dimmable daylighting system to maintain this design level throughout the daylight hours and to turn the lights off completely whenever the lighting levels exceed the design levels by 10%.
- F. BAS Controls – Coordination and Integration
 - 1. Coordinate with the Division 23 temperature control contractor for wiring, integrating, and programming of building automation system (BAS) to control lighting contactors as indicated. Refer to the drawings for specific zones of control and time scheduling requirements. Coordinate final settings directly with the COTR.

3.6 SYSTEM STARTUP AND SYSTEM COMMISSIONING

- A. System Startup: Manufacturer's authorized technician shall confirm proper installation and operation of system components.
 - 1. Confirm lighting controls are located, installed, and adjusted as required by the factory and the contract documents for each room.
 - 2. Verify operation of each lighting control device as specified. Confirm time-delay settings comply with initial time-delay settings listed in the contract documents.
 - 3. Verify lighting controls function as a complete and operational system to meet requirements of the Energy Code and the contract documents.
 - 4. Manufacturer shall submit test documentation for each room including a written statement verifying that system meets above requirements. Include copy of test reports in the Operation and Maintenance Manual.
- B. System Commissioning: Commissioning of lighting control devices and digital lighting management systems shall be as indicated in Section 260800. Manufacturer's certified installer of lighting control systems shall coordinate and assist in all commissioning requirements by third party. Each system and devices shall be fully programmed and functioning as specified prior to commissioning.
- C. Factory authorized representative will be available for a pre-wiring meeting to review submittal drawings, recommended wiring practices and programming requirements.
- D. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system. Provide notice no-less than three weeks prior to a startup visit. Several business days may be required to confirm dates and times.

- E. Provide written or computer-generated documentation on the commissioning of the system including room by room description including:
 - 1. Sensor parameters, time delays, sensitivities, and daylight-harvesting setpoints.
 - 2. System programming (e.g., manual on, auto off, dimming levels, zone switching, etc.).

3.7 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Nonconforming Work:
 - 1. Lighting control devices will be considered defective if they do not pass tests and inspections.
 - 2. Remove and replace defective units and retest.
- C. Prepare test and inspection reports.

3.8 Not Used.

3.9 DEMONSTRATION

- A. Coordinate demonstration of products and training of Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training" for requirements, excluding requirements related to video-recordings. Include in this contract training/demonstration time plus any necessary travel time/expenses.
 - 1. Lighting Control Relay Panels: 2 hours.

3.10 MAINTENANCE

- A. Software and Firmware Service Agreement: Install and program software upgrades that become available as specified above.

END OF SECTION 260923

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. MCCB: Molded-case circuit breaker.
- D. SPD: Surge protective device.
- E. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 1. Include dimensioned plans, elevations, sections, and details.
 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
 4. Detail bus configuration, current, and voltage ratings.
 5. Short-circuit current rating of panelboards and overcurrent protective devices.
 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

7. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Panelboard Schedules: For installation in panelboards Submit final version to match installed conditions and additional loads.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

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. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or ISO 9002 certified.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Handle and prepare panelboards for installation according to NEMA PB 1.

1.10 FIELD CONDITIONS

- A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 40 deg C.
 - b. Altitude: Not exceeding 2000 m.

- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet (2000 m).
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 1. Notify Owner no fewer than two days in advance of proposed interruption of electric service.
 2. Do not proceed with interruption of electric service without Owner's written permission.
 3. Comply with NFPA 70E.

1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
 1. Panelboard Warranty Period: 18 months from date of Substantial Completion.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.
 1. PD Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. ABB (Electrification Products Division).
 2. Eaton.
 3. Schneider Electric USA (Square D).
 4. Siemens Industry, Inc., Energy Management Division
- B. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NEMA PB 1.
- F. Comply with NFPA 70.
- G. Enclosures: Surface-mounted, dead-front cabinets.
 1. Rated for environmental conditions at installed location.

- a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
2. Height: 84 inches (2.13 m) maximum.
3. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
- H. Incoming Mains:
 1. Location: Convertible between top and bottom.
 2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.
- I. Phase, Neutral, and Ground Buses:
 1. Material: Hard-drawn copper, 98 percent conductivity.
 - a. Plating shall run entire length of bus.
 - b. Bus shall be fully rated the entire length.
 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
- J. Conductor Connectors: Suitable for use with conductor material and sizes.
 1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Terminations shall allow use of 75 deg C rated conductors without derating.
 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
 4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
 5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
- K. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
 1. Future spaces: number as indicated in panelboard schedules on the drawings.
- L. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
 1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.

2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.
- M. Provide factory installed integral SPDs in new Panelboards which serve emergency systems (NEC 700), and as indicated on the drawings.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
- B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 2.

2.3 POWER PANELBOARDS

- A. Panelboards: NEMA PB 1, distribution type.
- B. Mains: as indicated on plans.
- C. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers or Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers or Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- B. Mains: as indicated on plans.
- C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents. Circuit breaker types, frame sizes, and functionality shall be as required to meet the overcurrent device selectivity requirements as noted in 26 05 70 Coordination Study, but not less than as noted below:
1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.

- b. Instantaneous magnetic trip element for short circuits.
- c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- 2. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.
 - d. Multi-button keypad to access programmable functions and monitored data.
 - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
 - f. Integral test jack for connection to portable test set or laptop computer.
 - g. Field-Adjustable Settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long and short time adjustments.
 - 4) Ground-fault pickup level, time delay, and I squared T response.
- 3. Subfeed Circuit Breakers: Vertically mounted.
- 4. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
 - f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - g. Rating Plugs: Three-pole breakers with ampere ratings greater than amperes shall have interchangeable rating plugs or electronic adjustable trip units.
 - h. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - i. Multipole units enclosed in a single housing with a single handle.

2.6 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.7 ACCESSORY COMPONENTS AND FEATURES

- A. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NEMA PB 1.1.
- D. Equipment Mounting:
 - 1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
 - 2. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- E. Mount top of trim 78 inches (2000 mm) above finished floor unless otherwise indicated.
- F. Mount panelboard cabinet plumb and rigid without distortion of box.
- G. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- H. Mount surface-mounted panelboards to steel slotted supports 1-1/4 inch (32 mm) in depth. Orient steel slotted supports vertically.
- I. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.

2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- J. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- K. Install filler plates in unused spaces.
- L. Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
- B. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- C. Tests and Inspections:
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."

3.6 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

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. GFCI receptacles, 125 V, 20 A.
 - 3. Twist-locking receptacles.
 - 4. Toggle switches, 120/277 V, 20 A.
 - 5. Wall plates.

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.

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.

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.
- 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.
- H. Wall Plate Color: For plastic covers, match device color.
- I. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.
- J. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).
 - 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

- A. Straight Blade Receptacles, 125 V, 20 A :

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 5361 (single), 5362 (duplex).
 - b. Hubbell; HBL5361 (single), 5362 (duplex).
 - c. Leviton; 5361 (single), 5362 (duplex).
 - d. Pass & Seymour; 5361 (single), 5362 (duplex).
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 GFCI RECEPTACLES, 125 V, 20 A

A. Duplex GFCI Receptacles, 125 V, 20 A :

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper: SGF20
 - b. Hubbell: GFRST20_ST (AutoGuard™)
 - c. Leviton: G5362
 - d. Pass & Seymour: 2095
2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Type: Feed through.
5. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

2.4 TOGGLE SWITCHES, 120/277 V, 20 A

A. Single-Pole Switches, 120/277 V, 20 A :

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper: CSB120
 - b. Hubbell: CSB120
 - c. Leviton: 1221-2
 - d. Pass & Seymour: CSB20AC1
2. Standards: Comply with UL 20 and FS W-S-896.

B. Three-Way Switches, 120/277 V, 20 A :

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper: CSB320
 - b. Hubbell: CSB320
 - c. Leviton: 1223-2
 - d. Pass & Seymour: CSB20AC3
2. 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: Smooth, high-impact thermoplastic.
 - 3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.

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. Pigtailing 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 (152 mm) 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 up, and on horizontally mounted receptacles to the left.
 - a. In existing buildings, match the configuration of existing devices.
- 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. Group adjacent switches under single, multigang wall plates.

3.2 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- B. Tests for Receptacles:
1. Line Voltage: Acceptable range is 105 to 132 V.
 2. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 3. Using the test plug, verify that the device and its outlet box are securely mounted.
 4. 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.
- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 265100 - LIGHTING

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. LED interior lighting.
2. Exit lighting.
3. Luminaire accessories and support components.

B. Related Requirements:

1. Section 260923 "Lighting Control Systems and Devices" for automatic control of lighting, including controllers/dimmers, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured delivered output of luminaire.
- G. Luminaire: Complete lighting unit, including light source, reflector, integral or remote driver, circuitry, lens, diffuser, housing, and accessories.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description, profiles, and dimensions of luminaires.
4. Include finishes for luminaire-supporting devices.
5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
6. Photometric data and adjustment factors based on laboratory tests, complying with IES LM-79 and IES LM-80.

a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

7. Use same luminaire designations as indicated on Drawings.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, unique configurations, and mounting and attachment details.
2. Include details of luminaire 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.

C. Finish/Color Samples for Initial Selection or Verification: As specified for specific luminaire types on the Luminaire Schedule for each type of luminaire requiring a custom factory-applied finishes/colors.

1. Include samples of luminaires and accessories involving color and finish selection.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

B. Warranty documents.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. As indicated on drawings.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications:

1. Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
 2. Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- B. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- C. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.
1. Obtain Architect/Engineer's approval of luminaires in mockups before starting installations.
 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect/Engineer specifically approves such deviations in writing.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- D. IESNA RP-16-05 Addendum "A": Industry-standard nomenclature and definitions of lighting terms and lighting technologies, including solid-state (LED) luminaires.
- E. UL Compliance: Comply with UL 1598 as specified.
- F. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 and UL 924, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application. Comply with NFPA 101.
- G. Source Limitations:
1. Provide luminaires from a single manufacturer for each luminaire type
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.
- 1.9 WARRANTY
- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
1. Structural failures, including luminaire support components.
 2. Faulty operation of luminaires and accessories.

3. Deterioration or corrosion of metals, metal finishes, color retention, and other materials beyond normal weathering.
- B. Luminaire Warranty Period: Greater than four (4) years from date of Substantial Completion.
1. If the manufacturer's warranty commences upon the date materials are delivered, then the manufacturer's warranty period must be at least five (5) years to meet the requirement stated above.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance:
1. Luminaires shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.
 2. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified".
 3. Component Importance Factor: 1.5.
- B. Structural Characteristics: Comply with AASHTO LTS-6-M.
- C. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied according to AASHTO LTS-6-M.
- D. Live Load: Single load of 500 lbf (2200 N) distributed according to AASHTO LTS-6-M.
- E. Ambient Temperature (Indoor Lighting): 5 to 104 deg F (-15 to +40 deg C).
1. Relative Humidity: Zero to 95 percent.
- F. Altitude: Sea level to 1000 feet (300 m).

2.2 LUMINAIRE REQUIREMENTS

- A. Luminaire Types and Acceptable Manufacturers: As indicated on the Drawings. Refer to the Luminaire Schedule.
1. Model numbers shall not be regarded as complete or entirely accurate. Do not order products based solely on a model number. For each luminaire type, the contractor shall reconcile its description, including options and accessories, with its intended application derived from relevant information conveyed throughout the entirety of contract documents.
 2. The manufacturer listed first for each luminaire type shall be regarded as the Basis of Design. Alternative products by other listed manufacturers must be at least equivalent in style, quality, features, and performance to that of the Basis of Design.

- 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. Factory-Applied Labels: Comply with UL 1598. Include CCT and CRI ratings. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
- D. Recessed luminaires shall comply with NEMA LE 4.

2.3 LED LUMINAIRES

- A. Delivered lumen output as indicated on the Luminaire Schedule.
- B. IESNA LM-79 compliant, latest edition.
- C. IESNA LM-80 compliant, latest edition; 50,000 hours minimum, unless otherwise noted.
- D. CRI and CCT as indicated on Luminaire Schedule in accordance with ANSI C78.377.
- E. NEMA.SSL-1 compliant for operational characteristics and electrical safety of LED drivers and power supplies. ANSI/NEMA C82.77 compliant for maximum allowable harmonic distortion produced by power supplies/drivers.
- F. Power Factor > 0.9, unless noted otherwise.
- G. Total Harmonic Distortion (THD) < 20%, unless noted otherwise.
- H. Provide integral Type 4 surge protective device (SPD) rated for 10 kA peak surge per UL 1449 standards.

2.4 EXIT SIGNS

- 1. General Characteristics: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- 2. Internally Lighted Sign:
 - a. LED; 100,000 hours minimum rated lamp life.
 - b. Provide AC-only non-emergency type (without battery) for exit signs connected to line-voltage emergency power circuit as indicated on the Drawings.

2.5 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Steel:

1. ASTM A36/A36M for carbon structural steel.
 2. ASTM A568/A568M for sheet steel.
 3. Epoxy-coated.
- C. Stainless Steel:
1. Manufacturer's standard grade.
 2. Manufacturer's standard type, ASTM A240/240M.
- D. Galvanized Steel: ASTM A653/A653M.
- E. Aluminum: ASTM B209. Corrosion-resistant.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit servicing without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during servicing and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.
- G. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation (UV-stabilized). Lens Thickness: At least 0.125 inch minimum, unless otherwise indicated.
- H. Glass Lenses, Diffusers, or Globes: Annealed crystal glass, tempered Fresnel glass, unless otherwise indicated. Acrylic lenses

2.6 FINISHES

- A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Finishes and Color Selections: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping.
1. Finishes/colors to be selected by the Architect/Engineer from the manufacturer's full range of standard finishes/colors during the review of action submittals, unless the color is specifically indicated on the Luminaire Schedule.
 2. If noted on the Luminaire Schedule, provide custom color matching Architect's color sample or RAL designation.
- D. Factory-Applied Finish for Aluminum Luminaire: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
- E. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
- F. Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces according to SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
 2. Powder Coat: Comply with AAMA 2604. Electrostatic-applied powder coating; single application and cured to a minimum 2.5- to 3.5-mil dry film thickness. Coat interior and exterior of pole for equal corrosion protection

2.7 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12-gage.
- D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

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

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect/Engineer, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.
- C. Coordinate layout and installation of luminaires with other construction. Do not modify layout or locations of luminaires without documented approval to do so, unless indicated otherwise on the Drawings.
- D. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- E. Adjust luminaires that require field adjustment or aiming to provide optimum illumination. Coordinate and confirm final adjustments with Owner.
- F. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- G. Fasten luminaire to structural support.
- H. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and servicing.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- I. Flush-Mounted Luminaires:
 - 1. Secured to outlet box.
 - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 - 3. Trim ring flush with finished surface.
- J. Wall-Mounted Luminaires:
 - 1. Attached to structural members in walls or a minimum 20-gauge or 1/8-inch thick backing plate attached to wall structural members.

2. Attached using through bolts and backing plates on either side of wall as recommended by luminaire manufacturer.
3. Do not attach luminaires directly to gypsum board.

K. Suspended Luminaires:

1. Pendant mount, where indicated, minimum 5/32-inch-diameter aircraft cable supports, adjustable, and quantity of supports as indicated or as recommended by luminaire manufacturer, whichever is greater.
2. Hook mount, where applicable.
3. Rods: Where longer than 48 inches, brace to limit swinging.
4. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
5. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod or wire support as indicated for suspension for each unit length of luminaire chassis, including one at each end.
6. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

L. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.4 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems."

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Perform the following tests and inspections:
 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

2. Verify settings, programming, functions, and operation of components integral to the luminaire, whether dimming drivers, integral presence sensors, or photoelectric sensors—in addition to other control systems specified in Section 260923 “Lighting Control Systems and Devices.”
3. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
4. Inspect luminaires for nicks, mars, dents, scratches, and other damage.

C. Luminaire will be considered defective if it does not pass operation tests and inspections.

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.7 STARTUP AND SYSTEMS COMMISSIONING

A. Comply with requirements for startup and system commissioning specified in Section 260923 "Lighting Control Systems and Devices."

B. CLEANING

1. Thoroughly clean each installed luminaire within one month of substantial completion.

END OF SECTION 265100

SECTION 283111 – ADDRESSABLE FIRE ALARM SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provision of Contract, including General and Special Conditions and Division 1 Specification Section, apply to work of this Section.
- B. Related Sections:
 - 1. General and Special conditions
 - 2. Division 1: Submittals
 - 3. Division 7: Firestopping
 - 4. Division 9: Painting
 - 5. Division 21: Sprinkler System, Fire Pumps
 - 6. Division 26: Basic Electrical Requirements

1.2 SUMMARY

- A. Scope: The contract drawings are conceptual. This work includes demolishing existing fire alarm smoke detectors, strobes and combination speaker-strobes, and installing new devices in kind in existing locations as part of a ceiling replacement in the International Gallery space at 1100 Jefferson Drive SW, Washington, DC 20004. Included in the work is the design of the new fire alarm signaling and smoke detector layout. The system shall include all wiring, raceways, pull boxes, outlet and mounting boxes, initiating devices, alarm notification appliances, and all other accessories and miscellaneous items required to maintain a complete operating system even though each item is not specifically mentioned or described.
- B. Existing Equipment: Existing or temporary fire alarm equipment shall be maintained operational until the new equipment has been tested and accepted by the Smithsonian Institution Authority Having Jurisdiction. As new equipment is installed, it shall be labeled "NOT IN SERVICE" until the new equipment is accepted. Once the new system is accepted by the Smithsonian, the labels on the new equipment shall be removed and the existing equipment shall be labeled "NOT IN SERVICE" until removed from the building. Just prior to demolition and construction activities (dust producing activities), dust covers should be installed over smoke detectors and the duct detector for the air handling unit serving the area. The dust covers are to be removed at the end of every workday. An in-line filter shall be installed for each air-sampling unit to prevent dust infiltration. This filter must be maintained and replaced by the Contractor for the duration of construction.
- C. Equipment Removal: After acceptance of the new system by the Smithsonian, all existing equipment not connected to the new system shall be removed and all damaged surfaces shall be

restored to finishes similar to surrounding walls/ceiling/floor. Detectors shall remain covered during removal and while in storage. Operational equipment which was removed shall be carefully packaged, labeled, and turned over to the COTR. Other material, such as conduit and electrical boxes, shall be removed from the site and disposed of by the Contractor.

- D. Repair/Service Replacement Parts: Repair services and replacement parts for the system shall be furnished under this contract after the date of final acceptance of work by the Smithsonian Institution. On-site service during the warranty period shall be provided within 24 hours after notification. All repairs shall be completed within 48 hours after notification.
- E. As the scope of work involves one for one replacement of existing smoke detectors and alarm notification appliances only, existing annunciators, control equipment and interface equipment will not be replaced. The performance requirements in section 1.5 are provided to describe the existing system and the required, maintained performance of the system after replacement of the devices within scope.

1.3 DEFINITIONS

- A. COTR: Contracting Officer Technical Representative
- B. FM: FM Global (Factory Mutual)
- C. FPE: Fire Protection Engineer
- D. Furnish: To supply the stated equipment or materials
- E. Install: To set in position and connect or adjust for use
- F. NFPA: National Fire Protection Association
- G. NICET: National Institute for Certification in Engineering Technologies
- H. OSHM: Office of Safety Health and Environmental Management
- I. Provide: To furnish and install the stated equipment or materials
- J. UL: Underwriters Laboratories

1.4 SYSTEM DESCRIPTION

- A. The existing System is a complete, supervised, noncoded, addressable multiplex fire alarm system with voice/strobe evacuation, dual channel intelligent analog alarm initiation, conventional smoke detection initiation, and complying with all aspects of the applicable documents listed herein, and satisfying the performance requirements that follow. The existing System functionality and features are to remain after replacement of existing smoke detectors and alarm notification appliances under this scope.

1.5 PERFORMANCE REQUIREMENTS

- A. Replacement of existing smoke detectors and alarm notification appliances on existing System shall maintain the performance requirements described in this section.
- B. Comply with NFPA 72, all contract documents, and the Smithsonian Fire Protection and Life Safety Design Manual.
- C. The system shall be classified as a proprietary protective signaling system.
- D. Control features:
 - 1. The system fire alarm control panel shall be tied-to the Smithsonian Institution central monitoring system, which is manufactured by Keltron Corporation. The Keltron system uses the existing SI network to communicate fire alarm conditions. A compatible fire alarm system, the appropriate Keltron LS Net transceiver and associated network connections must be installed.
 - 2. Any intelligent analog smoke detector or conventional smoke detector zone shall include a selectable alarm confirmation capability. Alarm conditions on these devices are processed through a confirmation period of 45 seconds. Over the next 300 seconds, a signal justification period is initiated where any subsequent alarms are reported immediately.
 - 3. A subprogram shall be provided to allow environmental compensating for smoke detector sensitivity. Each smoke detector shall be programmed with this capability.
 - 4. The system shall provide a field-test function where one person can test the complete system or a specified area at the fire alarm control panel while maintaining full operational function of other areas not under test. Alarms, troubles, device types, and the initiation device addresses shall be logged to historical memory.
 - 5. Provide a manual pull station attached to the fire alarm control panel that activates the general alarm. Resetting the manual pull station (and all other activated alarms) will cause the general alarm to cease operating. OSHEM must approve the final sequence of operation.
 - 6. Provide program capability via switches or buttons in a locked portion of the fire alarm control panel to bypass the notification appliance circuits, air handler shutdown, smoke control operation, elevator recall, fire door release, horizontal/vertical fire curtain release, and door unlocking features. Operation of these switches or buttons shall indicate this action as a supervisory signal on the FACP display.
 - 7. History Logging - recirculating last 500 events, minimum. History shall be downloadable by classification for selective event reports.
- E. Supervision

1. Class B initiating device circuits.
 2. Class B signaling line circuits for each floor.
 3. Class X signaling line circuits for the network.
 4. Class B notification appliance circuits.
 5. Provide electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control panel.
 6. Provide electrical supervision of the circuits leading to interfacing modules for the monitoring of contact type initiation devices, the control of electrical devices, fire pump controllers, load control relays (controlling elevators and HVAC equipment), and each independent smoke detection, kitchen, and gaseous fire suppression systems.
- F. Alarm Functions: Fire alarm system functions and operations shall be as indicated below. A fire alarm sequence of operation shall be provided in the shop drawings. Operation of an alarm initiating device shall cause the functions indicated on the matrix to occur as described below:
1. Sound General Evacuation Alarm: This function shall cause all strobe lights to activate and speakers in the building to sound a slow whoop for 3 cycles followed by the voice message,

"May I have your attention please! May I have your attention please! A fire has been reported in the building. Please walk to the nearest exit and leave the building. Do not use the elevators."

2. This is repeated until the control panel is reset. After the digital message has ended, or if the digitally prerecorded message shall fail for any reason, the alarm signal shall revert to a slow whoop, which will continue until manually silenced. It shall also be possible to preempt the whoop signal or prerecorded voice evacuation message and sound a live message from the microphone at the Fire alarm Master CPU location on a floor-by-floor basis. All floors not selected for a manual message shall continue to receive the pre-recorded message or whoop signal.
 3. Release Held-Open Fire Doors: This function shall cause all fire doors in the building that are held open by electrical hold-open/release mechanisms to be released, and allowed to close.
 4. Unlock Time Delay Hardware on Exit Doors: This function shall cause a signal to be sent to all exit doors provided with electrically operated locks to become unlocked and free for egress.
 5. Shutdown Supply Fan Served: This function shall cause the air handling system supply fan to shut down.

6. Close Smoke Damper: This function shall cause smoke dampers installed in HVAC systems to shut down.
 7. Initiate Stairwell Pressurization: This function shall initiate the stairwell pressurization systems in each building stairwell. Each stairwell has a separate pressurization system that will be independently activated. The fire alarm system shall provide any and all such interfaces/control points as required to properly activate this smoke management system.
 8. Initiate Elevator Recall: This function shall cause a signal to be sent to the elevator controller recalling the elevator to the preselected floor, or if the activated initiation device is on the preselected floor, the elevator will be recalled to the preselected secondary floor. Recall shall be initiated for all elevators served by a common shaft, elevator machine room, or elevator lobby.
 9. Shutdown Power to Elevator Equipment: This function shall cause a signal to be sent to a shunt trip switch in the power circuit serving the elevator to cause elevator shutdown. This shall be typical for all elevators served by a common shaft, elevator machine room or elevator lobby.
 10. Activate Fire Suppression System Served: This function shall cause a signal to be sent to an interface device to operate a solenoid and activate a fire suppression system.
 11. Shutdown Exhibit Hall Audio/Visual Equipment: This function shall cause a signal to be sent to a circuit shunt trip causing audio/visual equipment to shut down.
 12. Illuminate LED on Device in Alarm: This function shall cause an LED, integral to a device, to illuminate, indicating that the device is in alarm. For contact devices, such as sprinkler valve tamper switches, the LED shall be built into the intelligent system interface module monitoring the device.
 13. Activate audio/visual signals and display address on the FACP: This function shall illuminate an alarm indicating LED, sound an audible alarm, and display a device address at the FACP when the system is in an alarm condition.
 14. Activate Audio/Visual Signals and Address Display on Remote Panel or Graphic Annunciator Panel: This function shall cause the event to be transmitted to a remote panel, whose location is shown on the drawings. The message sent shall be the same message displayed on the FACP LCD display board.
 15. Signal Confirmation: This function shall cause the fire alarm control panel to reset the activated device and wait for a second alarm activation. Alarm conditions are processed through a confirmation period of 45 seconds. Over the next 300 seconds, a signal justification period is initiated where any subsequent alarms are reported immediately.
- G. Trouble Functions: Provide the following actions and indications at the FACP upon a single break, open condition, or ground fault on all supervised circuits which may prevent the required operation of the system:

1. Annunciate at the FACP: A yellow visual signal, audible alarm, and alphanumeric LCD display of type of trouble, and device address.
2. Send a signal to the existing central monitoring system. This message shall include the building of origin as well as all information indicated to be displayed on the FACP.
3. Send a signal to the remote panel shown on the drawings. This message shall include the building of origin as well as all information indicated to be displayed on the FACP. The message sent shall be the same message displayed on the FACP LCD display board.
4. Each independent fire detection, kitchen, and fire suppression system shall be monitored for trouble conditions. Each monitored condition shall be provided with a separate address.

H. Fire Alarm Signal Initiation Shall Be By One Or More Of The Following Devices:

1. Manual pull station
2. Heat detector
3. Smoke detector
4. Projected beam detector
5. Aspiration Smoke Detector Alarm
6. Automatic sprinkler system water flow switch.
7. Combustible Gas Detection System
8. Conventional initiation device zone (for legacy systems)
9. Flame detector

I. Supervisory signal initiation shall be by one or more of the following devices or actions:

1. Operation of a fire-protection system valve tamper switch.
2. Operation of the building fire pump or pump running signal and/or any associated fire pump system troubles/ supervisory signals.
3. Duct smoke detector
4. Laser Scanner Aspiration Smoke Detector Alert
5. Operation of any non-fire system as designated on the Matrix.
6. Generator running
7. Generator fault

8.

J. System trouble signal initiation shall be by one or more of the following devices or actions:

1. Loss of primary power at the FACP.
2. Ground or a single break in FACP internal circuits.
3. Abnormal A/C voltage at the FACP.
4. A break in standby battery circuitry.
5. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
6. Failure of battery charging.
7. Abnormal position of any switch at the FACP or annunciator.
8. Amplifier failure
9. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.

1.6 SUBMITTALS

- A. General: Refer to Section "SUBMITTALS" for basic information relating to submittal requirements. Partial submittals will not be acceptable and will be returned without review. Before any work is commenced, the submittal must be approved by the Office of Safety, Health and Environmental Management (OSHEM). Any work performed by the contractor prior to their approval will be at the contractor's own risk. If such work is contrary to applicable codes and contract documents, the contractor shall bear all costs including, but not limited to, demolition, reconstruction, and all costs and expenses associated with revising the fire alarm system to meet all applicable codes and contract document requirements. All working drawings shall be a minimum 24 in by 36 in. Electronic submittals in PDF based format are also acceptable.
- B. System Description: Submit a detailed description of the control panel as it shall operate for this specific installation. General system descriptions from the catalog cuts and copies of the Systems Design Operation portion of this specification will not be acceptable. All equipment shall be compatible and listed/approved for operation with one another. Any accessory panel shall be compatible with the fire alarm panel(s).
- C. Equipment: Include annotated catalog data showing manufacturer's name, model, voltage, and catalog numbers for all equipment and components of the following:
 1. Annunciation devices (speakers, strobes, bells, etc.)
 2. Fire Detector (smoke, heat, flame, video, etc.)
 3. Wire

4. Boxes
 5. Conduit
 6. Support
- D. Shop Drawings: Provide working drawings in an electronic file. Shop drawings shall be prepared on a Computer Aided Drafting (CAD) System. As a minimum, the shop drawing submittal shall include the following:
1. Point to point wiring diagrams on floor plans at a scale of not less than 1/8" = 1'-0" (1:100), showing all field devices (indicating and initiating devices, relays, switches, etc.), field interconnections, the routing of conduit and circuits between devices, electrical boxes, terminal cabinets, risers, and the FACP. All device circuit numbers and addresses shall be indicated. The device circuit number and addresses on the point-to-point wiring diagram shall be in logical/sequential order (ie.L1D1, L1D2, etc.).
 2. Field wiring color code scheme.
 3. Locations for all ceiling mounted equipment shall be coordinated with lighting fixtures, air outlets, ductwork and other fixtures. All detectors shall be centered and aligned with ceiling tiles and/or other ceiling mounted devices.
 4. Complete riser diagrams indicating the wiring sequence of all devices and their connections to the control equipment. Provide a color code schedule for the wiring.
 5. Detailed sequence of operations and matrix.
- E. As-Built (Record) Working Drawings: On a daily basis the contractor's superintendent shall record as-built conditions on a set of Shop Drawings maintained at the job site. Shop Drawings reflecting as-built conditions shall be available prior to the final acceptance test. Two weeks after the acceptance test and before final acceptance of the work, submit electronically as-built drawings. The drawings shall include:
1. As-built locations of all devices and equipment. Point to point wiring diagrams on floor plans at a scale of not less than 1/8" = 1'-0" (1:100), showing all field devices (indicating and initiating devices, relays, switches, etc.), field interconnections, the routing of conduit and circuits between devices, electrical boxes, terminal cabinets, risers, and the FACP. All device circuit numbers and addresses shall be indicated. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
 2. Riser diagram
 3. All deviations from the project drawings and approved shop drawings

- F. Record Drawing Software: Submit electronically CAD based drawings in DXF and PDF format of all as-built drawings and schematics. All as-built submittals shall also be digitally transmitted to the COTR.
- G. Device Addresses: Prior to fire system installation, provide for approval a complete list of device addresses with corresponding commands, controls, and sequence of operation.
- H. Qualification Data: For Designer and Installer.
- I. Strobe and Voice Evacuation Circuit Labels: Prior to fire system installation, provide for approval a complete list of area descriptions for strobe and voice evacuation circuits to be labeled on the fire alarm panel.
- J. Service Manuals and Equipment Descriptions : Thirty days prior to the final acceptance test and after the preliminary testing has been completed submit the following for items within scope:
 - 1. Furnish electronically complete service manuals to include: device and board specifications, operation, installation, and maintenance manual; manufacturers installation instructions for all aspects of the new installation; Test Mode Operating Instructions; manufacturer's wiring specifications for the system; training manual.
 - 2. Maintenance checklists for new equipment.
 - 3. As-built circuit diagrams, complete with color-code scheme, and device descriptions.
 - 4. Complete parts list by make model number and manufacturer.
 - 5. List of smoke detector addresses and corresponding sensitivity readings.
 - 6. Copies of approved submittal materials.
- K. Calculations:
 - 1. .
 - 2. Voltage drop calculations for NAC wiring runs demonstrating worst-case condition. Show capability of 25 or 70.7 vrms circuits for wire runs.
 - 3.
- L. FACP Wire Chart: Prepare a system wire chart. Chart every wire showing the wire number, color, size, type of circuit, designation, origination point and termination point. The chart shall be typewritten with a minimum 12-point lettering on paper that is 8.5 inches by 11 inches. The format of the wire chart shall be as shown on the contract drawings. Provide one copy of the wire chart in a sealed plastic envelope inside the fire alarm control panel.
- M. Terminal Cabinet Wire Chart: Prepare a wire chart of the wires in each terminal cabinet. Chart every wire showing the wire number, color, size, type of circuit, designation, origination point and termination point. The chart shall be typewritten with minimum 12-point lettering. The format of the wire chart shall be as shown on the contract drawings. The chart must be protected

with a clear laminate and mounted in each cabinet so that it does not interfere with the wiring or terminals.

- N. **Work Schedule:** All work must be coordinated with facility operations. Museum operations may require limited access to areas, arranging for museum security personnel to accompany contractors in non-public areas, and working during off-hours. Prior to initial work, meet with museum staff to establish a work schedule. A work schedule must be submitted for approval prior to initial work.
- O. **Certificate of Compliance:** Within two weeks after passing the acceptance test, submit a certificate of code and contract compliance to the COTR in accordance with NFPA 72.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications

- 1. **Testing Services or Laboratories:** Construct all fire alarm and fire detection equipment in accordance with the latest edition of the following publications from Underwriters Laboratories (UL) and Factory Mutual Engineering Corporation (FM):
 - a. UL Fire Protection Equipment Directory
 - b. UL Electrical Construction Materials Directory
 - c. UL 38 – Manually Actuated Signaling Boxes for Use With Fire Protection Signaling Systems
 - d. UL 228 – Door Holding Devices
 - e. UL 268 - Smoke Detectors for Fire Protective Signaling Systems
 - f. UL 268A - Smoke Detectors for Duct Application
 - g. UL 464 - Audible Signal Appliances
 - h. UL 497A – Secondary Protectors for Communications Circuits
 - i. UL 521 - Heat Detectors for Fire Protective Signaling Systems
 - j. UL 864 - Control Units for Fire Protective Signaling Systems
 - k. UL 1283 – Electromagnetic Interference Filters
 - l. UL 1449 - Transient Voltage Surge Suppressors
 - m. UL 1480 - Speakers for Fire Protective Signaling Systems
 - n. UL 1971 - Signaling Devices for the Hearing Impaired
 - o. FM Approval Guide

2. Codes and Standards, Latest Edition
 - a. International Building Code
 - b. NFPA 70, National Electrical Code
 - c. NFPA 72, National Fire Alarm and Signaling Code
 - d. NFPA 101, Life Safety Code
 - e. Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG).
 - f. ASME/ANSI A 17.1, Safety Code for Elevators and Escalators
- B. Qualifications of Installer:
1. Installer shall have an office, which has been in existence for at least 3 years, within a 121-kilometer (75 mile) radius of the project site.
 2. Installation shall be accomplished by an electrical contractor with a minimum of five years' experience in the installation of fire alarm system of similar size and capacity.
 3. The installer shall be at minimum NICET Level II in fire alarm systems and shall be onsite when any work on the fire alarm system is performed.
 4. The services of a technician provided by the contractor shall be provided to supervise installation, adjustments, and tests of the system. This technician shall have a NICET Level III on staff to verify that the work is being done correctly.
 5. The certifications of the installer and technician must be part of the submittals and must be approved by OSHEM prior to the start of their work. If the installer or technician is changed at any point during the project, the credentials of the replacement must be submitted and approved prior to the start of their work.
- C. Distributor/ Service Organization/ Designer Qualifications: Design Personnel certified by NICET as Fire Alarm Level III or IV or a registered fire protection engineer. The manufacturer's equipment distributor shall show evidence of certification by the manufacturer in the technical support of the system installed under this contract.
1. The distributor shall show evidence of certification of at least one employee by the NICET at Level III or IV in the Fire Alarm Systems subfield of Fire Protection Engineering Technology. If such a certified individual is not employed, adequate documentation shall be provided to show comparable training and experience of an existing employee. At a minimum, comparable training and experience shall consist of ten years of progressive experience in the installation and design of fire alarm systems of similar size and complexity to that specified herein.

2. In lieu of an employee with NICET Level III or IV certification, the distributor shall show evidence of at least one employee with a minimum of ten years of progressive experience in the design of fire alarm systems. In addition, the distributor shall show evidence of technical support in the design, installation, and testing of the systems from a manufacturer-affiliated company, which shall show evidence of certification of at least one employee by the NICET at level III or IV in the Fire Alarm Systems subfield of Fire Protection Engineering Technology.
 3. The contractor shall furnish evidence that the fire alarm equipment supplier has an experienced and effective service organization, which carries a stock of repair parts for the system being furnished. Should the Contractor fail to comply with the service requirements of this section, the Smithsonian will then have the option to make the necessary repairs and back-charge contractor without any loss of warranty as provided by the contract documents.
 4. The control equipment manufacturer shall provide an employee certified in the inspection, testing and maintenance of the panel and/or equipment being installed, to assist in the final connections to the panel. This individual shall also assist with pre-testing and acceptance testing.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 DELIVERY STORAGE AND HANDLING

- A. Deliver products to project site in original, unopened packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, and shelf life if applicable.
- B. Store materials inside, under cover, above ground, and kept dry and protected from physical damage until ready for use. Remove from site and discard wet or damaged materials.

1.9 PROJECT CONDITIONS

- A. Interruption of Existing Fire Alarm Service: Do not interrupt fire alarm service to facilities occupied by The Smithsonian Institution or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
 1. Notify COTR no fewer than two days in advance of proposed interruption of fire alarm service.
 2. Do not proceed with interruption of fire alarm service without The Smithsonian Institution's written permission.
 3. No system shall be out of service during non-business hours unless a fire watch is established.

4. System troubles shall be documented at the beginning of a work shift. Any troubles created during the shift shall be brought to the COTR's attention and rectified before end of shift if requested.

1.10 TEMPORARY FIRE PROTECTION

A. The following sprinkler and fire alarm phasing sequence shall be adhered to:

1. During the demolition phase, the sprinkler system shall remain in place and active until all combustible materials are removed from the project site and demolition is largely complete.
2. Until the completion of major hot work activities, to include welding, cutting, and grinding, the sprinkler system shall remain in place and active.
3. At no time shall the work area not be protected by either the existing sprinkler system; temporary fire alarm system, new sprinkler system, or new fire alarm system.
4. Staging and storage areas shall be provided sprinkler protection at all times during construction.

B. Suggested sequence for fire alarm and sprinkler phasing:

1. Existing sprinkler system remains in place and active
2. Existing fire alarm system in the work area is removed with the exception of monitoring the existing sprinkler system
3. Project demolition is performed
4. Major hot work, including welding, cutting, and grinding is performed
5. Upon completion of major demolition and associated demolition hot work, temporary fire alarm (smoke detection and notification) is installed and connected to the building fire alarm system
6. Upon completion of the temporary fire alarm system and approval by OSHEM and the COTR, contractor may demolish the remaining fire alarm system and the existing sprinkler system except sprinkler protection shall be preserved in staging and storage areas
7. Installation of the new systems (fire sprinkler and fire alarm) takes place
8. Temporary systems are taken offline once new systems are accepted.

C. MC cable may be utilized for temporary fire alarm systems. All temporary MC cable must be removed prior to project close-out.

1.11 COORDINATION

- A. Coordinate device layout with reflected ceiling plan and all ceiling-mounted equipment, including diffusers, lights, security cameras, fire alarm devices, exit signs, and other devices.
- B. Coordinate major equipment and aspiration smoke detection piping layouts with other trades to avoid obstructions and excessive changes in direction for piping.

1.12 WARRANTY:

- A. The contractor shall guarantee labor, materials, and equipment provided under this contract against defects for a period of one year after the final acceptance of this work by the Smithsonian and after the receipt of as-built drawings and schematics of all equipment.

1.13 EXTRA MATERIALS

- A. Spare parts shall be directly interchangeable with the corresponding components of the installed system. Spare parts shall be suitably packaged and identified by nameplate, stamping or tagging.
- B. Furnish the following spare parts. Quantity shall be two percent of the installed number of devices, but not less than the quantities listed:
 - 1. Smoke Detectors of each type installed: 2
 - 2. Audio/visual devices: 5
 - 3.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements and compatibility to Smithsonian monitoring system, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Wire and Cable:
 - a. As per Division 26, and Part 3 of this specification.
 - 2. Conduit:
 - a. As per Division 26, and Part 3 of this specification
 - 3. Boxes, supports, terminal blocks, and appurtenances:
 - a. As per Division 26, and Part 3 of this specification.

2.2 FIRE DETECTORS

- A. Photoelectric light scattering type smoke detectors shall be provided as follows:
 - 1. Match existing devices.
- B.

2.3 NOTIFICATION APPLIANCES

- A. Speakers and strobes shall match existing devices.
- B. Strobe lights
 - 1. Strobe lights shall match existing devices.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment, materials, installation, workmanship, examination, inspection, and testing shall be in accordance with NFPA 72, except as modified herein.

3.2 SYSTEM FIELD WIRING AND CONDUIT

- A. Wiring within Cabinets and Junction Boxes: Provide wiring installed in a neat and workmanlike manner and installed parallel with or at right angles to the sides and back of any box or cabinet.
- B. Conductor Type and Size: Wire size shall be sufficient to prevent dropping voltage below specified minimum levels. Wire type and sizing of conductors shall also be in accordance with the manufacturer's wiring specifications. Minimum wire size and type shall be as follows, unless manufacturer's requirements conflict. Conflicts shall be brought to the attention of the COTR and OSHEM:
 - 1. Signaling Line Circuits: 16AWG, Type FPLR/FPLP, solid copper
 - 2. Notification Appliance Circuits: 14AWG, Type FPLR/FPLP, solid copper, twisted pair
 - 3. Speaker Circuits: 16 AWG, Type FPLR/FPLP, solid copper, twisted pair
- C. Connectors: All conductors shall be terminated at a screwed connector on a securely mounted approved pressure-type terminal block. The use of wire nuts or similar devices shall be prohibited.

- D. Conductor Numbering: All new conductors installed in the system shall be numbered at every junction point. Use a numbered shrink-wrap label designed specifically for this purpose. Wire numbers shall be the same as those designated on the as-built drawings. Mark each terminal in accordance with the wiring chart and diagrams of the system.
- E. Conductor Color Coding: Color coded conductors shall be consistent for each type of circuit. When renovating or adding to an existing system, color-coding shall match the existing system.
- F. Junction Boxes: Any junction/gang box used in a circuit shall sole be dedicated to that circuit. A common junction/gang box is not permitted for routing multiple circuits.
- G. Signaling Line and Notification Appliance Circuits
 - 1. Signaling Line, notification appliance, and power circuits shall each be in separate conduit.
 - 2. Strobes are to be connected to circuits separate from speakers. This includes strobes and speakers that are mounted as a unit.
 - 3. Provisions for tying-in signaling line and notification appliance circuits directly to the FACP mother board (board containing CPU) shall not be used. Initiation and indicating circuits shall be tied to a separate electronic board before connection to the motherboard.
- H. Circuit Loading:
 - 1. Spare capacity shall be in accordance with 1.07.
 - 2. Circuits operating at 24VDC shall not operate at less than 21.6volts. Circuits operating at any other voltage shall not have a voltage drop exceeding 10% of nominal voltage.
- I. Conduit:
 - 1. All conductors shall be in grounded metal conduit. Conduit shall be Rigid metal or EMT. Flexible metal conduit not exceeding six-foot lengths shall be permitted from junction box to initiating device. On flexible metal conduit, use only insulated throat connectors.
 - 2. Run conduit or tubing concealed unless specifically shown otherwise on the drawings.
 - 3. Minimum conduit size shall be 3/4-inch.
- J. Circuits to Interfaced Equipment:
 - 1. Circuits to smoke management systems, fan shutdown systems, door locking systems, A/V shutdown, fire door release, and firefighter telephones in elevator cabs shall terminate in terminal cabinets within 914mm (3 feet) of the controllers for those systems.

3.3 FIRESTOPPING:

- A. Seal all holes caused by penetrating conduit, piping, or other penetrations that pass through floors, walls or ceilings. Firestop penetrations through floor slabs, fire-rated walls, shafts, or any fire-rated assembly in accordance with Section 078413, Penetration Firestopping.

3.4 MARKING:

- A. All metal surfaces shall be painted. Metal conduit in finished areas shall be painted the color to match adjacent surfaces. Junction boxes in unfinished areas shall be painted full gloss enamel red. Painting shall be in accordance with Section 099000.
- B. Red bands shall be applied every 10 feet (3.05m) when not using red-colored conduit.
- C. Prior to acceptance testing each fire alarm initiating and notification device must be labeled with the device address.
- D. Device coverage maps shall be provided adjacent to each aspirating smoke detection unit. Maps shall mark the coverage area of each pipe on the detection unit. Maps shall be sized at 11"x17" minimum.

3.5 DEVICE INSTALLATION:

- A.
- B. Strobes: Wall mount strobes shall be a minimum of 80 inches (2032 mm) above the finished floor or 6 inches (152 mm) below the ceiling whichever is lower.
- C. Speakers: Speakers should typically be set on the 1/2 watt tap. Speakers in areas with ceilings above 3048 mm (10 feet) shall be set on the 1-watt tap.
- D. Smoke Detectors:
 - 1. Install smoke detectors a minimum of 3 feet (914 mm) away from supply air vents.
 - 2. New smoke detectors shall be installed with dust covers. The dust covers shall be removed just prior to acceptance testing.
 - 3. The indicating LED on the smoke detector shall be visible from the floor. Where ceiling conditions prevent easy viewing of the LED from the floor, a remote indicating lamp must be installed.

3.6 TESTS

- A. Test Equipment: The contractor shall supply personnel, communication devices, and all equipment necessary for performance of the final test.

- B. Megger Tests: After all wiring has been installed, and prior to making any connections to panels or devices, all wiring shall be megger tested for insulation resistance, grounds, and/or shorts. Conductors with 300 volt rated insulation shall be tested at a minimum of 250 VDC. Conductors with 600 volt rated insulation shall be tested at a minimum of 500 VDC. The tests shall be witnessed by OSHEM, SI Life Safety Group, and the Contracting Officer and test results recorded for use at the final acceptance test.
- C. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests shall be witnessed by the Contracting Officer, OSHEM and the SI Life Safety Group. Test results shall be recorded for use at the final acceptance test.
- D. Preliminary Testing: Conduct preliminary tests to ensure that all devices and circuits are functioning properly. After preliminary testing is complete, provide a letter to the COTR certifying that the installation is complete and fully operable. The letter shall state that each initiating and indicating device was tested in place and functioned properly, including proper device message descriptions and proper placement of graphic icons in fire alarm systems with graphic notification equipment. The letter shall also state that all panel functions were tested and operated properly. The Contractor and an authorized representative from each supplier of equipment shall be in attendance at the preliminary testing to make necessary adjustments.
- E. Final Acceptance Test: Notify the Contracting Officer in writing when the system is ready for final acceptance testing. Submit request for test at least 14 calendar days prior to the test date. A final acceptance test will not be scheduled until megger test results, the loop resistance test results, preliminary testing letter, and the submittals required in Part 1 are provided to the Contracting Officer. Test the system in accordance with the procedures outlined in the NFPA 72 and as follows
1. Verify the absence of unwanted voltages between circuit conductors and ground
 2. Verify that the control unit is in the normal condition as detailed in the manufacturer's operating and maintenance manual.
 3. Complete operational tests under emergency generator power
 4. Complete operational tests under battery power and as described above under battery power. Test the battery charger.
 5. Test each initiating and indicating device and circuit for proper operation and response. Disconnect the confirmation feature for smoke detectors during tests to minimize the amount of smoke or test gas needed to activate the detector.
 6. Test the system for all specified functions in accordance with the contract drawings and specifications and the manufacturers operating and maintenance manual.
 7. Verify several of the audibility results that were recorded on the as-built drawings as part of the preliminary testing above.
 8. Visually inspect all wiring.

9. Verify that shop drawings reflecting as-built conditions are accurate.
10. Measure voltage readings for circuits to assure that voltage drop is not excessive.
11. Measure the voltage drop at the most remote appliance on each notification appliance circuit.
12. All faults and trouble signals associated with the completed work must be cleared from the panel.

a.

3.7 TRAINING

- A. Instructor: Include in the project the services of an instructor, who shall have received specific training from the manufacturer for the training of other persons regarding the inspection, testing and maintenance of the system provided. The instructor shall train the Smithsonian employees designated by the Contracting Officer, in the care, adjustment, maintenance, and operation of the fire alarm system.
- B. Training sessions shall cover all aspects of system performance, including system architecture, signaling line circuit configurations, sensor and other initiating device types, locations, and addresses, fire alarm control panel function key operation, and other functions as designated by the COTR.
- C. Required Instruction Time: Provide 8 hours of instruction after final acceptance of the system. The instruction shall be given during regular working hours on such dates and times as are selected by the Contracting Officer. The instruction may be divided into two or more periods at the discretion of the Contracting Officer. One training session shall be videotaped by the contractor. Videotapes shall be delivered to the COTR.
- D. Comprehensive system troubleshooting training shall be provided for a single individual designated by the COTR. This session shall be separate and distinct from the above-described sessions.
- E. All training sessions shall be conducted following final system certification and acceptance. Three additional training sessions shall be provided for all security personnel on all shifts six months after final system certification.
- F. All training sessions shall be conducted by an authorized fire alarm system distributor representative, who has received specific training from the manufacturer for the training of other persons regarding the inspection, testing, and maintenance of the system provided.

END OF SECTION 283111