

SECTION 260500 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The "General Conditions" and "Special Conditions" of Contract as written and referred to hereinbefore are adopted and made part of Division 26.

1.2 DESCRIPTION OF WORK:

- A. Provide equipment, labor, etc., required to install complete working electrical system as shown and specified.
- B. Provide fixed electrical equipment, except where specifically noted otherwise.
- C. Provide portable electrical equipment for complete system.
- D. Provide equipment and/or wiring normally furnished or required for complete electrical systems but not specifically specified on the drawings or in specifications, as though specified by both.
- E. All equipment and wiring shall be new.
- F. Electrical work includes, but is not limited to:
  - 1. Arrange with local utility companies for services as shown or specified.
  - 2. Removal or relocation of electrical services located on or crossing through project property, above or below grade, obstructing construction of project or conflicting with completed project or any applicable code.
  - 3. Alterations and additions to existing electrical systems.
  - 4. Complete 600 volt Distribution System. Provide meters, switchboards, panelboards, circuit breakers, power outlets, convenience outlets, switches, and/or other equipment forming part of system.
  - 5. Complete raceway systems and terminal facilities for telephone system.
  - 6. Connection of all appliances and equipment.
  - 7. Complete alterations and additions to emergency lighting and power system.
  - 8. Complete empty conduit raceways and outlet boxes only for sound system.
  - 9. Complete alterations and additions to fire alarm system.
  - 10. Complete empty raceway system(s) for auxiliary system(s) as shown.
  - 11. Complete intercommunication systems in music venue by Clear Comm
  - 12. Complete conduit and wiring for voice data system.
  - 13. Complete additions and alterations to existing lightning protection system.
  - 14. Complete interior and exterior lighting.
  - 15. Complete dimming control system.
  - 16. Complete central lighting control system.

1.3 WORK NOT INCLUDED:

- A. Furring for conduit and equipment.
- B. Finish painting of conduit and equipment.
- C. Installation of motors except where specifically noted.
- D. Control wiring for mechanical systems, except where indicated to be provided by Electrical Contractor.
- E. Installation of telephone instruments and wiring.
- F. Flashing of conduits into roofs and outside walls. Inform General Contractor of number and size of roof penetrations prior to bidding.

1.4 RELATED WORK SPECIFIED ELSEWHERE:

- A. Classification of excavation: Architectural Division.
- B. Painting: Painting Division.
- C. Concrete Work: Concrete Division.

1.5 REQUIREMENTS OF REGULATORY AGENCIES:

- A. Obtain and pay for all permits required for the work. Comply with all ordinances pertaining to work described herein.
- B. Install work under this Division per drawings, specifications, latest edition of the National Electrical Code, Local Building Codes, and any special codes having jurisdiction over specific portions within complete installation. In event of conflict, install work per most stringent code requirements determined by Architect
- C. Arrange, pay fees for and complete work to pass required tests by agencies having authority over work. Deliver to Architect Certificates of Inspection and approval issued by authorities.

1.6 QUALIFICATIONS OF CONTRACTOR:

- A. Has completed minimum two projects same size and scope in past five (5) years.
- B. This qualification applies to Sub-Contractors.
- C. Use workmen experienced in their respective trade. Submit qualifications of Superintendent for review.
- D. Owner reserves right to reject bid of any Contractor failing to meet these qualifications.

## 1.7 GENERAL JOB REQUIREMENTS:

## A. Drawings and Specifications:

1. Electrical work is shown on "E" series drawings inclusive. Follow any supplementary drawings as though listed above.
2. Drawings and specifications are complementary. Work called for by one is binding as if called for by both.
3. Drawings show general run of circuits and approximate location of equipment. Right is reserved to change location of equipment and devices, and routing of conduits to a reasonable extent, without extra cost to Owner.
4. Refer conflicts between drawings and specifications describing electrical work and work under other Divisions to Architect for remedial action.
5. Use dimensions in figures in preference to scaled dimensions. Do not scale drawings for exact sizes or locations.
6. Execution of Contract is evidence that Contractor has examined all drawings and specifications related to work, and is informed to extent and character of work. Later claims for labor and materials required due to difficulties encountered, which could have been foreseen had examination been made, will not be recognized.
7. Charges for extra work not allowed unless work authorized by written order from Architect approving charge for work.

## B. Visit to Site:

1. Visit site to survey existing conditions affecting work. Include necessary materials and labor to accomplish the electrical work, including relocation of existing services and utilities on building site in bid. No consideration given to future claims due to existing conditions.

## C. Definitions:

- |     |          |  |
|-----|----------|--|
| 1.  | Provide: | Furnish, install and connect complete.             |
| 2.  | Wire:    | Furnish all necessary wiring and connect complete. |
| 3.  | Install: | Set in place and wire complete.                    |
| 4.  | Work:    | Materials completely installed and connected.      |
| 5.  | AWG:     | American Wire Gage.                                |
| 6.  | NEC:     | National Electrical Code (latest edition)          |
| 7.  | NFPA:    | National Fire Protection Association.              |
| 8.  | OSHA:    | Occupation Safety and Health Administration.       |
| 9.  | UL:      | Underwriters Laboratories, Inc.                    |
| 10. | NEMA:    | National Electrical Manufacturers Association.     |
| 11. | IEEE:    | Institute of Electrical and Electronic Engineers.  |

## D. Workmanship, Guarantee and Approval:

1. Work under this Division shall be first class with emphasis on neatness and workmanship.
2. Install work using competent mechanics, under supervision of foreman, all duly certified by local authorities. Installation subject to Architect's constant observation, final approval, and acceptance. Architect may reject unsuitable work.
3. Furnish Architect written guarantee, stating that if workmanship and/or material executed under this Division is proven defective within one (1) year after final acceptance, such defects and other work damaged will be repaired and/or replaced.
4. In event that project is occupied or systems placed in operation in several phases at Owner's request, guarantee will begin on date each system or item of equipment is accepted by Owner.

- E. Observations of Work and Demonstration of Operation:
1. At all observations of work, open panel covers, junction box covers, pull box covers, device covers, and other equipment with removable plates for check. Provide sufficient personnel to expedite cover removal and replacement.
  2. Contractor to assist Architect in demonstration of operation of new systems to satisfaction of Owner. Contractor to have manufacturer available for demonstration of systems where requested by Owner.
- F. Testing of Electrical Systems:
1. Test Completed work as follows:
    - a. Perform test required by Engineer to indicate compliance with specifications, drawings and applicable codes. Provide instruments, labor and materials for tests.
    - b. Insulation - use 1000 VDC insulation tester (0-500 megohm full-scale), equal to "Megger" as manufactured by Biddle Company. Test conductors and busses of all systems, including feeders, main service busway, branches, motors, devices, equipment, etc. Test branches for one (1) minute; test feeders, bus ducts, busses, etc., for 15 minutes with readings at one minute intervals.
    - c. Receptacles:
      - (1) Use Woodhead Ground Loop Impedance Tester. Test each receptacle. Record readings.
  2. Ground Testing:
    - a. Testing of Made Ground Electrodes:
      - (1) Test Ground Systems Indicated.
      - (2) Using a measuring device which generates minimum of 500 VDC, calibrated in ohms (maximum 200 ohm scale) J.C. Biddle "Vibrotester" or approved equivalent.
      - (3) Provide test electrode in accordance with Measuring Device Manufacturer's instructions. Use ground rods as specified in Section "Grounding".
      - (4) Follow instructions of measuring device manufacturer for proper results.
      - (5) Test grounds only when earth is dry.
      - (6) Record ambient temperature, date, time, approximate water table level (as obtained from local geologists); type of earth material.
  3. High Potential "Hi Pot" Testing of Equipment:
    - a. Test cable and equipment indicated on plans or in specifications. Use D.C. high potential tester, as manufactured by J.C. Biddle or approved equivalent. Test equipment used capable of producing minimum specified voltage plus 25% additional voltage.

b. Cable:

- (1) Test per IP CEA No. S-68-516 (NEMA WC8-1976).
- (2) Underwriters Laboratories Standard 1072.
- (3) Use voltage level as recommended by manufacturer of cable except not less than:

<u>Cable Rating</u>	<u>Test Voltage</u>	<u>Test Voltage</u>
	(New Cable)	(Old Cable)
5 KV	35 KV	25 KV
8.7 KV	40 KV	30 KV
15 KV	55 KV	40 KV
35 KV	100 KV	75 KV

4. Dry Type Transformers:

a. Test in accordance with following standards as applicable:

- (1) IEEE Standard 259
- (2) IEEE Standard 262-1973
- (3) ANSI C57.12.90.1973
- (4) NEMA TRI-1968

b. Use voltage level as recommended by equipment manufacturer, except not less than:

(1) <u>Rating</u>	<u>Test Voltage</u>
600 V	1.5 KV
2.4 KV	6.1 KV
5 KV	12.75 KV
7.6 KV	19.3 KV
15 KV	38.25 KV

- 5. Test interval - 15 minutes. Graph microampere leakage vs. time with values plotted each 30-60 seconds. Test to be discontinued if erratic results are observed. Test records include date, ambient temperature, relative humidity, and time of day.
- 6. Record all test results in loose leaf log for Owner. Test information required: Date of test; name of circuit or equipment; ambient temperature; weather conditions; final instrument readings; graph of readings for 15 minutes tests. Provide three copies of log.
- 7. Architect (or) Engineer will observe tests. One week prior notice required.

G. Materials and Substitutions:

- 1. All material shall be new, with U.L. label where available. If U.L. label is not available, material shall be manufactured in accordance with applicable NEMA; IEEE and Federal Standards.
- 2. No material shall be substituted for specified, except by prior written approval of Architect. Specified catalog numbers are used for description of equipment and standard of quality only. Equivalent material given consideration only if adequate comparison data including samples are provided. Approval required prior to bid date. Bid substituted material only if approved in writing by Architect.

3. Submit to Architect within 30 days after award of contract a complete list of proposed material manufacturers. List does not preclude submission of shop drawings. Approval of manufacturer on list does not constitute approval of specific material or equipment.

H. Shop and Erection Drawings:

1. Submit complete shop drawings for all material and equipment furnished under Division 26 of specifications, to Architect for review within (30) days after award of contract. Shop drawings shall be submitted on timely basis to allow adequate lead time for review, re-submission if necessary, manufacture and delivery to allow access of material to project at correct time based on schedule established by Architect/Contractor. Include complete descriptive data with dimensions, operating data and weight for each item of equipment. Carefully examine shop drawings to assure compliance with drawings and specifications prior to submittal to Architect Shop drawings and submittals shall bear the stamp of approval of the Electrical and General Contractor as evidence drawings have been checked by them. Drawing submitted without this stamp of approval will not be considered and will be returned for proper resubmission.
2. Drawings larger than 8-1/2" x 11", submit 1 reproducible of each drawing. Architect will retain a digital copy and return 1 reproducible copy to Contractor. Contractor is responsible for copying reproducible for distribution.
3. 8-1/2" x 11" drawing in brochure: Submit digital copies for review Architect will retain a digital copy and a digital copy to Contractor.
4. Review of shop drawings does not relieve Contractor of responsibility for errors and omissions in shop drawings. Contractor is responsible for dimensions and sizes of equipment. Inform Architect in writing of equipment differing from that shown.
5. Prepare erection drawings when required by Architect. Investigate thoroughly all conditions affecting work and indicate on drawing. Architect will review erection drawings before work commences.
6. Provide for Owner three (3) sets of final shop and erection drawings, except provide 1 set of digitally reproducible copy of shop drawings larger than 8-1/2" x 11" size.
7. Coordination shop drawings will be required for the following areas, drawn to a scale of not smaller than 1/4" - 1'-0":
  - a. Electrical equipment rooms and areas.
  - b. Electrical and mechanical equipment areas.
  - c. Start drawings as HVAC shop drawings indicating all ductwork piping, equipment and locations of mechanical room floor drains, and electrical connections. Indicate elevations of all ductwork and piping. Draw sections as required to clarify congested situations.
  - d. Next, the Plumbing Section shall add all piping and plumbing equipment to the drawings.
  - e. Next, the Fire Protection Section shall add all sprinkler heads and fire protection piping.
  - f. Next, the Electrical Sections shall add all electrical fixtures, conduit and equipment.
  - g. Next, the drawings shall be submitted to the General Contractor for final coordination.
  - h. Finally, after the General Contractor has approved the drawings they shall be submitted to the Architect for approval.

I. Cooperation:

1. Carefully coordinate work with other contractors. Refer conflicts between trades to Architect
2. Work to be installed as progress of project will allow. Schedule of work determined by General Contractor and/or Architect

## J. Maintenance and Operating Instructions for Equipment:

1. Submit to Architect three (3) sets of reproducible data prepared by manufacturer for each item of electrical equipment completely describing equipment. Data to include parts lists, description of operation, shop drawings, wiring diagrams, maintenance procedures and other literature required for maintenance of equipment. Bind in booklet form for presentation.

## K. Record Drawings:

1. Contractor shall maintain at the site one (1) copy of the drawings in good order and marked to record all changes made during construction.
2. Contractor shall update all drawings to incorporate all changes and deliver one (1) set of reproducible plans and one (1) electronic copy of the project in the latest "AutoCAD" version to the Owner upon completion of the work.

## L. Items for Owner:

1. Provide following items for Owner at time of substantial completion:
  - a. Certificates of inspection and approval from authorities having jurisdiction.
  - b. Written guarantees.
  - c. "Record" blue line prints.
  - d. Final approved shop drawings (3 sets).
  - e. Spare fuses (furnish receipt).
  - f. Maintenance data (3 sets).
  - g. Affidavit of Owner Instruction (1 copy).

## M. Marking:

1. Identify each starter, (including starters furnished under Mechanical Section), panelboard, cabinet, control device, breaker, disconnect and safety switch with 1/4" high black letters cut in a white laminated phenolic strip. Use red letters for all equipment connected to emergency system. Attach to enclosure with two (2) metal screws.
2. Outlets for emergency shall be similarly engraved in red.
3. Nameplates required for other items in this Division similar to those described above.

## N. Protection and Storage:

1. Provide warning lights, bracing, shoring, rails, guards and covers necessary to prevent damage or injury.
2. Do not leave exposed or unprotected, electrical items carrying current. Protect personnel from exposure to contact with electricity.
3. Protect work and materials from damage by weather, entrance of water or dirt. Cap conduit during installation.
4. Avoid damage to materials and equipment in place. Repair, or remove and replace damaged work and materials.
5. Exercise particular care when working around telephone (electronic) equipment to prevent entrance of dust, moisture and debris into the equipment. Provide dust barriers and partitions as required.
6. Deliver equipment and materials to job site in original, unopened, labeled container. Store to prevent damage and injury. Store ferrous materials to prevent rusting. Store finished materials and equipment to prevent staining and discoloring. Store materials affected by condensation in warm dry areas. Provide heaters. Storage space on site and in building designated by Owner/Architect

7. Install equipment per manufacturer's recommendations. Conflicts between contract documents and these recommendations, deferred to Architect
- O. Excavation and Backfill:
1. Excavate for work in this Division.
  2. Avoid existing facilities in excavating. Contractor is responsible for repair and replacement of damaged facilities in executing work.
  3. Backfill in twelve inch (12") lifts, wetted down and tamped. Compaction minimum 95% of adjacent earth.
  4. Repairing to be comparable to work cut including new asphalt paving, concrete paving, sod, replanting shrubbery, etc. Architect will observe repair work, and reject unsuitable work.
- P. Cutting and Repairing:
1. Cut and repair walls, floors, roof, etc., required to install work. Where work cut is finished, employ original installer of finish to repair finish. Do not cut structural members.
- Q. Anchors:
1. Provide anchors for all equipment, raceways, hangers, etc. to safely support weight of item involved. Anchors to consist of expansion type devices similar to "Redhead" or lead expansion anchors. Plastic anchors are not acceptable. Protect telephone equipment from drilling residue.
- R. Cleaning and Painting:
1. Clean equipment furnished in this Division after completion of work.
  2. Touch-up or re-paint damaged painted finishes.
  3. Remove debris, packing cartons, scrap, etc., from site.
- S. Starters:
1. Separately mounted starters are furnished under another Division, but installed in Division 26 unless specifically noted otherwise.
- T. Control Wiring:
1. Control Wiring including low voltage and line voltage interlock wiring is provided in Division 26 as shown on drawings and specified herein. Submit Control Wiring shop drawings where indicated.
- U. Code Compliance:
1. Entire electrical installation shall comply with all aspects of code including local interpretations. This includes but is not limited to:
    - a. Installation adjustment to meet all code clearances between electrical such as ductwork, other HVAC, plumbing, fire protection, and structural systems.
    - b. Locations for items such as fire alarm appliances, exit lights, egress lighting, disconnect switches, etc.



2. No additional compensation will be allowed for code compliance. Notify engineer of difficulty encountered for assistance.

END OF SECTION 260500

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
  - 1. Building wires and cables rated 600 V and less.
  - 2. Connectors, splices, and terminations rated 600 V and less.

1.3 DEFINITIONS

- A. VFC: Variable frequency controller.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

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

1.6 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following Basis-of-Design Product. Subject to compliance with requirements, provide or comparable product by one of the following:
  - 1. Alcan Products Corporation; Alcan Cable Division.

2. Alpha Wire.
3. Belden Inc.
4. Encore Wire Corporation.
5. General Cable Technologies Corporation.
6. Southwire Incorporated.

- B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
- C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THW-2, Type THHN-2-THWN-2, Type XHHW-2, and Type SO.
- D. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC and Type SO with ground wire.

## 2.2 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
  1. AFC Cable Systems, Inc.
  2. Gardner Bender.
  3. Hubbell Power Systems, Inc.
  4. Ideal Industries, Inc.
  5. IIsco; a branch of Bardes Corporation.
  6. NSi Industries LLC.
  7. O-Z/Gedney; a brand of the EGS Electrical Group.
  8. 3M; Electrical Markets Division.
  9. Tyco Electronics.
- C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

## 2.3 SYSTEM DESCRIPTION

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

## PART 3 - EXECUTION

### 3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 and No. 12 AWG and smaller; stranded for No. 8 AWG and larger.

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

- A. Service Entrance: Type THHN-2-THWN-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN-2-THWN-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-2-THWN-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.
- E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Metal-clad cable, Type MC.
- F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.
- G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

### 3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

### 3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-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.
  - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

### 3.5 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.

### 3.6 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."

### 3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

### 3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements.
    - a. Emergency distribution and lighting control systems.
  - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
    - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
    - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

- c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
  
- D. Test and Inspection Reports: Prepare a written report 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.
  
- E. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes grounding and bonding systems and equipment, plus the following special applications:
  - 1. Underground distribution grounding.
  - 2. Ground bonding common with lightning protection system.
  - 3. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
  - 1. Ground rods.
  - 2. Grounding arrangements and connections for separately derived systems.
- B. Qualification Data: For testing agency and testing agency's field supervisor.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
  - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - a. Instructions for periodic testing and inspection of grounding features at ground rings and grounding connections for separately derived systems based on NETA MTS.

- 1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
- 2) Include recommended testing intervals.

## 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
  1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with UL 467 for grounding and bonding materials and equipment.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
  1. Burndy; Part of Hubbell Electrical Systems.
  2. Dossert; AFL Telecommunications LLC.
  3. ERICO International Corporation.
  4. Fushi Copperweld Inc.
  5. Galvan Industries, Inc.; Electrical Products Division, LLC.
  6. Harger Lightning and Grounding.
  7. ILSCO.
  8. O-Z/Gedney; A Brand of the EGS Electrical Group.
  9. Robbins Lightning, Inc.
  10. Siemens Power Transmission & Distribution, Inc.

### 2.2 SYSTEM DESCRIPTION

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

### 2.3 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.



## B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

## 2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

## 2.5 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad, 3/4 inch by 10 feet (19 mm by 3 m).

## PART 3 - EXECUTION

## 3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
  1. Bury at least 24 inches (600 mm) below grade.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Conductor Terminations and Connections:
  1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

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

### 3.2 GROUNDING AT THE SERVICE

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

### 3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

### 3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

### 3.5 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all 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. Single-phase motor and appliance branch circuits.
  5. Three-phase motor and appliance branch circuits.
  6. Flexible raceway runs.
  7. Metal-clad cable 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. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from

panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

- F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- G. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.
- H. Metallic Fences: Comply with requirements of IEEE C2.
  - 1. Grounding Conductor: Bare, tinned copper, not less than No. 8 AWG.
  - 2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
  - 3. Barbed Wire: Strands shall be bonded to the grounding conductor.

### 3.6 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
  - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
  - 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
  - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
  - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

- E. Grounding and Bonding for Piping:
  - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
  - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
  - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- F. 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.
- G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.
- H. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.
  - 1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.

### 3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
  - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
  - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal at individual ground rods. Make tests at ground rods before any conductors are connected.
    - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural

- drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
- b. Perform tests by fall-of-potential method according to IEEE 81.
4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- E. Grounding system will be considered defective if it does not pass tests and inspections.
  - F. Prepare test and inspection reports.
  - G. Report measured ground resistances that exceed the following values:
    1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
    2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
    3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
    4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohms.
    5. Substations and Pad-Mounted Equipment: 5 ohms.
  - H. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

## SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Hangers and supports for electrical equipment and systems.
  - 2. Construction requirements for concrete bases.

#### 1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Steel slotted support systems.
  - 2. Nonmetallic slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
  - 1. Trapeze hangers. Include Product Data for components.
  - 2. Steel slotted channel systems. Include Product Data for components.

3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.8 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
  1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.
    - c. ERICO International Corporation.
    - d. GS Metals Corp.
    - e. Thomas & Betts Corporation.
    - f. Unistrut; Atkore International.
    - g. Wesanco, Inc.
  3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
  5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  6. Channel Dimensions: Selected for applicable load criteria.

- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.
    - c. Fabco Plastics Wholesale Limited.
    - d. Seasafe, Inc.
  3. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
  4. Fitting and Accessory Materials: Same as channels and angles.
  5. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Hilti, Inc.
      - 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
      - 3) MKT Fastening, LLC.
      - 4) Simpson Strong-Tie Co., Inc.



2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
  - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Cooper B-Line, Inc.
    - 2) Empire Tool and Manufacturing Co., Inc.
    - 3) Hilti, Inc.
    - 4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
    - 5) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

## 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

### 3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
  - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
  - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
  - 7. To Light Steel: Sheet metal screws.
  - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

### 3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

- B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033053 "Miscellaneous Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
  - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

### 3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

## SECTION 260533 - RACEWAYS AND BOXES

### PART 1 - GENERAL

#### 1.1 DESCRIPTION OF WORK:

- A. Installation of raceway systems for all work in Division 26 and required fittings.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Metallic Raceways:

- 1. Republic
- 2. Wheatland
- 3. Allied
- 4. Alfex
- 5. Triangle
- 6. Walker
- 7. Anaconda
- 8. AFC

- B. Non-Metallic Raceways

- 1. Carlon
- 2. National Pipe & Plastics
- 3. CanTex
- 4. Allied

- C. Boxes and Fittings

- 1. Thomas & Betts: Steel City
- 2. Hubbell: RACO; Killark
- 3. Appleton
- 4. Midwest
- 5. EFCOR
- 6. Hoffman
- 7. OZ Gedney
- 8. Bridgeport
- 9. AFC

#### 2.2 RACEWAYS

- A. Rigid galvanized steel conduit to conform to ASA Standard C80.1 and U.L. Standard No. 6 for rigid metallic conduit, except hot dipped galvanized after threading.

- 1. Fittings, ells, couplings, etc., galvanized threaded type meeting above standards. Threadless fittings not allowed.

2. Terminate rigid conduit with two locknuts, one inside, one outside of the cabinet, junction or outlet and a bushing. Bushing - malleable iron with smooth Bakelite ring molded into edge of bushing to prevent damage to cable, OZ Mfg. Co., type "B" or approved equal. Where grounding bushings are required, construction of bushing similar to above except a lug provided for grounding connection, OZ type "BLG" or approved equal.
- B. Rigid intermediate grade conduit, IMC, to conform to UL Standard No.1242; hot dipped galvanized or approved equivalent.
1. All fittings, ells, couplings, etc., constructed to same standards as rigid steel conduit. Fittings - threaded type with all threads engaged. Use "Uni-swivel" couplings in dry locations only.
  2. Conduit terminations same as rigid steel conduit.
- C. Flexible steel conduit, "Greenfield", continuous spirally wound and inter-locked, threadless, galvanized conforming to U.L. and CSA Standards for flexible steel conduit.
1. Connectors and fittings galvanized steel, threadless type with insulated throats, U.L. approved for grounding means.
- D. Liquid tight flexible steel conduit constructed similar to flexible steel conduit above, except with polyvinyl chloride jacket.
1. Fitting Assembly - sealing type, with steel gland, nylon ring and ground cone inside locknut. All fittings with insulated throat, U.L. approved for grounding means.
- E. Electrical metallic tubing, EMT, threadless, steel type conforming to ASA Standard C80.3 galvanized inside and out, and with additional corrosion resistant finish.
1. Fittings, connectors, couplings, etc., insulated throat galvanized steel screw indenter.
- F. Plastic conduit, PVC, polyvinyl chloride compound, rated for direct burial, Schedule 40, except as noted otherwise.
1. Fittings same material as conduit and installed with watertight joint compound recommended by manufacturer.

### 2.3 OUTLET AND JUNCTION BOXES:

- A. Provide wiring devices, fixtures and special system outlets with outlet box. Use galvanized steel for concealed boxes and exposed boxes in dry locations. Use cast metal conduit fittings similar to "Condulets" or "Unilets" with threaded hubs for exposed boxes outside and exposed to moisture.
- B. Concealed outlets and exposed outlets in unfinished spaces for lights, switches, wall receptacles, etc.; consist of standard galvanized steel outlet boxes and plaster rings.
1. Provide 1/16" thick boxes and covers of form and dimension adapted to its specific use and location, kind of fixture to be used and number, size and arrangement of connecting conduits.
  2. Provide 3/8" fixture studs where required.
  3. Ceiling Outlet Boxes: 4" octagonal or 4-11/16" square as required, due to number of wires, and 2" deep minimum. Ceiling boxes in slabs concrete type. Plaster rings not required for ceiling outlet unless needed for device.

4. Paint junction boxes provided with blank covers to match surroundings, except use blank device plates in finished areas.
  5. Switch and receptacle outlet boxes: 4" square with plaster rings as necessary. Provide multigang boxes where shown or required. Provide metal barriers to separate emergency and normal service wiring per N.E.C.
- C. Use galvanized cast metal boxes, approved equivalent to Crouse-Hinds type "FS" or Appleton "condulets", with appropriate covers for wall outlets in exposed conduit work and exposed to moisture.
- D. Use galvanized cast iron boxes equivalent to Crouse-Hinds type GRF for ceiling outlets in exposed conduit work exposed to moisture.
- E. Use square cut steel outlet boxes for outlets exposed in finished locations. Use round or square to adapt to device installed. Wiremold, Hoffman or approved equivalent.

#### 2.4 LARGE JUNCTION BOXES:

- A. Furnish pull, tap and cable support boxes required by NEC for excessive number of 90 degree conduit bends, conductor taps and cable supports.
1. Box construction per NEC and manufactured with galvanized sheet steel, 12 gage minimum, with angle iron frame where required for rigidity; welded or bolted construction. Install bolts to prevent damage to cables in box.
  2. Boxes with removable screw type covers and plated screws. Provide split covers where necessary for access. Maximum single piece cover - 36" x 36".
  3. Provide separate junction boxes for each feeder. If conduit is installed so separate junction boxes are not practical, one large pull-box may be used with each set of feeder conductors separated by 12 gage steel barriers. Furnish junction box or each compartment in junction box with ground lug for connection of grounding conductor.

#### 2.5 CONDUIT BODIES:

- A. Conduit bodies shall be installed to provide ease of pulling conductors and to provide neat appearance of conduit installation, and as shown on drawings. Conduit bodies constructed of malleable iron or copper free aluminum castings. Bodies shall be finished with standard durable exterior coatings of manufacturer specified. Provide rollers in type "C" and type "LB" bodies, 1-1/4" size and larger. Provide gasketed plated steel or malleable iron covers.
- B. Conduit bodies shall be manufactured by Crouse-Hinds, Pyle National, Killark, Appleton, or approved equivalent.

### PART 3 - EXECUTION

#### 3.1 INSTALL CONDUIT AS FOLLOWS:

- A. Use rigid steel or intermediate grade conduit for:
1. Circuits run underground.
  2. Circuits run in concrete in contact with earth.
  3. Circuits in hazardous and wet locations.

4. Circuits exposed to mechanical damage.
  5. All feeders (1-1/4" diameter and larger).
  6. All motor circuits.
- B. Use electrical metallic tubing, EMT, for:
1. Branch circuits (conduit 1" diameter and smaller) in dry locations.
  2. Telephone circuits.
  3. Auxiliary systems and controls (low voltage systems such as fire alarm nurse call sound systems, etc.).
  4. Feeders run overhead in dry locations.
- C. Use PVC conduit for:
1. Circuits run underground where indicated.
  2. For branch circuits in concrete slab.
  3. Where specifically shown on drawings.
  4. No PVC shall be exposed.
- D. Size conduit per NEC. Minimum size 1/2" diameter, but no more than 3#12 installed in 1/2" conduit.
- E. Run conduit concealed where possible. Run concealed conduit above furred ceiling in an orderly manner. Multiple conduits grouped and run parallel.
- F. In concrete slab: Install conduits in center of concrete slabs and tie to reinforcing steel with tie wires. Do not install conduit larger than 1" in concrete slabs unless approved by Architect. Install with minimum of 2" between parallel runs. Do not cross conduits in slab unless necessary, then only one conduit crossover in 12" space.
- G. Exposed Conduit: Use only where specifically shown or approved. Run perpendicular to building walls and partitions and tight against structure. Conceal vertical portion of conduits where possible.
- H. Paint conduit fittings and threads exposed to moisture with Rustoleum silver paint after installation.
- I. Furnish offsets required to meet field conditions. Make bends in conduit in accordance with the National Electrical Code, except make minimum radius of 6 times conduit diameter or 6" whichever is greater. Bend IMC conduit without deforming.
- J. Where conduit crosses expansion joints, install expansion type fittings OZ type EX with bonding jumper or approved equal.
- K. Make connections to equipment away from wall with conduit extensions exposed from ceiling to floor, anchored with floor flange and/or angle frame as required. Make connections to equipment with flexible conduit from tee conduit in conduit riser.
- L. Vibrating equipment and equipment requiring adjustment, i.e.: motors, transformers, etc: make final connections with flexible conduit.
- M. Isolate conduit connections to equipment on roof from roof penetration of conduit with short section of flexible conduit between roof penetration and equipment.
- N. Use liquidtight flexible conduit where exposed to moisture, oil, etc.

- O. Install conduit to avoid hot water pipes. Maintain 9" clearance of such pipes, unless closer crossings are unavoidable. Maintain minimum 1" clearance from covering of pipe crossed.
- P. Support conduit per NEC. Support individual conduits with galvanized hangers and rods as follows:
- |                               |               |
|-------------------------------|---------------|
| 1" diameter and smaller ..... | 1/4" dia. rod |
| 1-1/4" to 3" diameter .....   | 3/8" dia. rod |
| Larger than 3" diameter ..... | 1/2" dia. rod |
- Q. Individual conduit hangers - Minnerallac, or approved equal. Support EMT near each joint. Support for multiple conduit runs consist of Unistrut channel as required with 1/2" diameter galvanized bolts or rods anchored to structure. Provide "U" bolt clamps for each conduit on hangers. Support vertical riser conduits with galvanized bolted clamps at each floor. Do not support conduit to ceiling support system.
- R. Terminate conduits entering sheet metal boxes with double locknuts and bushings. Terminate conduit exposed to moisture with watertight hubs.
- S. Install appropriate seal-off where conduits exit hazardous areas, areas of temperature differential etc.
- T. Where ground conductor installed in conduits 1-1/4" and larger provide grounding bushings, and bond full size ground wire to bushings and from bushing to box or cabinet. Bond with self-tapping screw and appropriate lug. Where ground wires are run in smaller conduits, bond to outlet and junction boxes with self-tapping screw lug. Provide other conduits with non-grounding bushings as described under another article.
- U. Conduit work in hazardous areas, or areas with large temperature differential: Use rigid steel or IMC conduit with sealing fittings, poured with hardening compound after conductors are pulled-in. Seals installed per NEC. Conduit seals Crouse-Hinds type EYS or approved equal.
- V. PVC Conduit Installation:
1. Above ground: Allow for expansion and contraction.
  2. Below grade: Encase in 3" sand fill. Backfill free of large rocks and debris.
  3. Make elbows, bends, etc., with heated bender when factory bends are not available.
    - a. When below slab, provide rigid elbows.
  4. Make cuts with hacksaw and deburr ends.
  5. Make joints as follows:
    - a. Clean outside of conduit to depth of socket, and inside of socket with approved cleaner. Apply solvent cement to interior of socket and exterior of conduit, Insert conduit in socket and rotate 1/4 to 1/2 turn and allow to dry.
  6. Where non-metallic conduit is used for power wiring install insulated ground wire, sized per NEC unless shown larger.
- W. Sleeves:
1. Provide sleeves for raceways penetrating floor and structural members. Sleeves consist of Electrical Metallic Tubing set in forms. (Exception: Use Schedule 40 PVC for individual ground conductors).



2. Size sleeves to allow 1/2" clearance around raceway extending from bottom of floor construction to 2" above floor, minimum sleeve size 2-1/2" diameter. After raceways are installed, seal space between the raceway and sleeve with non-hardening, fireproof, compound, CTC PR-855 sealant, T&B "Flame Safe" for 2 hour fire rating or approved equal.

### 3.2 INSTALLATION OF OUTLET BOXES:

- A. Fasten outlet boxes securely to structure.
- B. Set all flush outlet boxes so edge of device flange is flush with finished surface.
- C. Open no more knockouts in outlet box than required.
- D. Seal boxes during construction.
- E. Stagger back to back boxes 3" minimum. In rated walls use appropriate U.L. spacing.
- F. Coordinate and verify rough-in location and mounting height of all boxes with drawings and other trades prior to installation.
- G. Support All Boxes:
  1. Outlet boxes - with 1/4" diameter galvanized rods or bolts anchored to structure.
  2. Outlet boxes for surface mounted luminaires on furred ceilings with 3/4" channel iron fastened to ceiling channels. See Section covering "Luminaires".
  3. Pull, junction and cable boxes with 3/8" diameter galvanized rods or bolts (4 minimum).
  4. Support outlet boxes in metal stud partitions with support that spans between two studs. Caddy "SGB", "TSGB", or "RBS" hangers or equal.
- H. Install adjacent outlets at different levels in one vertical line where possible.
- I. Provide green covered bonding jumper, screw connected to outlet box in all receptacle boxes.
- J. Paint wiring connections in ground mounted outlets or floor outlets in wet locations with "Scotchkote" and fill box with "Duxseal".
- K. Mark outlet box covers with permanent ink markers to indicate circuit number(s) and panel of origination. Use black markers for normal service circuits and orange for emergency service.
- L. Use 4" octagonal boxes with blank covers for master outlets, installed to permit installation of collars by others.
- M. Where outlet boxes installed in unfinished concrete walls or columns, provide 1" deep plaster ring with box and ring set in position before the concrete is poured so concrete will fill around the ring and cover plate can be installed flush with the unfinished surface. In case of brick walls, follow same procedure with mason filling around the plaster ring with mortar.
- N. Install all outlets located on columns on centerline of column and bend or shift reinforcing so that the outlet box will be flush with the finished concrete. Provide plaster rings as required so that the plate is flush with the finished plaster or exterior concrete surface.
- O. Where outlets installed in waterproofed columns or walls, provide 6"x6"x3" deep wood box placed in the forms before concrete is poured. Box will be removed before waterproofing is

applied. General Contractor will waterproof wall and opening, after which Electrical Contractor will install outlet box. General Contractor will grout around box. Set boxes carefully so that cover plates will be flush.

- P. Install conduit bodies where shown or where required for sharp bends and/or aesthetics in raceway system. Do not use in lieu of pullboxes except in limited space or as directed by Architect.

### 3.3 INSTALLATION OF JUNCTION BOXES:

- A. All junction boxes shall be accessible.
- B. Securely fastened to structure.
- C. Exterior below grade boxes shall be embedded 6" of concrete on sides and bottom. Top shall be level with finished grade unless shown otherwise.
- D. There shall be no more knockouts opened in any box than are actually required.
- E. Protection during construction.
- F. Identify (See Specification Section 26 0553).

### 3.4 INSTALLATION OF GUTTERS:

- A. Mount gutters on 3/4" thick pressboard backboard, sized for devices to be mounted, 2 coats of Albi No. 107A fire retardant paint (install label on board), mount all equipment thereon.
- B. Run conductors in gutter without reduction in size, entire length of gutter.
- C. Connect individual taps from conductor to tapped device with ILSCO insulated tap devices sized for conductors used.
- D. Gutter Tops: for copper conductors shall be ILSCO type GTA or PTA with GTC or PTC insulating covers or by "TEE" compression lugs as manufactured by Anderson or Burndy, wrapped with Scotch #33 electrical tape to a thickness which equals insulation level of wire.

END OF SECTION 260533

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Division 07 Section "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
  - 1. Material: Galvanized sheet steel.
  - 2. Minimum Metal Thickness:
    - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
    - b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

## 2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
  - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:
    - a. Advance Products & Systems, Inc.
    - b. CALPICO, Inc.
    - c. Metraflex Company (The).
    - d. Pipeline Seal and Insulator, Inc.
    - e. Proco Products, Inc.

## 2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
  - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
    - a. Presealed Systems.

## 2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## 2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
  - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

## PART 3 - EXECUTION

### 3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
  - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
    - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
    - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
  - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
  - 3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
  - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
  - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
  - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

### 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. Systems and equipment requiring identification are shown on the drawings, and extent of identification is specified herein and in individual sections of work.
- B. Types of electrical identification include:
  - 1. Exposed conduit color marking.
  - 2. Buried cable and conduit warnings.
  - 3. Cable/conductor identification.
  - 4. Operational instructions and warnings.
  - 5. Danger signs.
  - 6. Equipment/system identification signs (nameplates).

1.2 SUBMITTALS:

- A. Manufacturer's Data:
  - 1. Product specifications and installation instructions for each material and device.
- B. Samples:
  - 1. Provide for each color, lettering style and other graphic representation.

PART 2 - PRODUCTS

2.1 ELECTRICAL IDENTIFICATION MATERIAL:

- A. Color-Coded Conduit Markers:
  - 1. Color code all conduit with 3/4 inch wide band of vinyl plastic electrical tape, 3M Company "Scotch 35", applied two (2) full turns around conduit, 6" from all conduit terminations into switchboards, panelboards, motor control centers, starters, cabinets, control panels, pullboxes, outlet boxes, etc., on each side of walls, floors or roof penetrated by conduit and where conduit enters wall to outlets below.

Conduit Color Code:

System:	Color:
120/208 Volts - Normal	Black
277/480 Volts - Normal	Yellow
120/208 Volts - Emergency	Black and Red
277/480 Volts - Emergency	Yellow and Red
Intercom / Paging / Music / Telephone / By others	Blue
Computer / By others / Monitoring / Security	Brown
Fire Alarm	Orange

- B. Where authority does not allow tape use paint acceptable to authority.
- C. Underground Line Marker / Warning tape:
  - 1. Permanent colored, detectable plastic tape with foil core (color per AWPA Standard for utility being identified), with continuous-printed legend; for direct-burial service; minimum 6" wide x 4 mils thick. Legend to indicate type service of cable (e.g. "WARNING: Buried Electric Line").
- D. Cable / Conductor Identification Bands:
  - 1. Manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers, wrap-around type; pre-numbered plastic coated, or write-on type with clear plastic self-adhesive cover flap, lettered to show circuit identification.
- E. Self-Adhesive Plastic Signs:
  - 1. Manufacturer's standard, self-adhesive, pre-printed, flexible vinyl signs for operational instructions or warnings. Sizes suitable for application and visibility, with proper wording for application.
  - 2. Color: Orange with black lettering.
- F. Danger Signs:
  - 1. Manufacturer's standard "DANGER" signs, baked enamel finish on 20 gage steel; standard red, black and white graphics; 14" x 10" unless 10" x 7" is largest which can be applied, or where larger size is needed for visibility use recognized explanation wording (as examples: HIGH VOLTAGE, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH).
- G. Engraved Signs (Nameplates)
  - 1. 1/8" thick melamine plastic laminate, complying with FS LP-387, sizes as indicated, engrave with standard letter style of sizes and wording indicated (1/4" letters minimum) white field, black letters for normal service; red field, white letters for essential service; yellow field, blue letters for D.C. service; orange field, white letters for UPS service. Punched for screws.
  - 2. Fasteners: Self-tapping stainless steel screws, except contact epoxy adhesive where screws cannot or should not penetrate substrate.
- H. Lettering and Graphics:
  - 1. Coordinate names, abbreviations and other designations used with those shown or specified. Provide numbers, lettering, and wording as indicated or required for identification and operation/maintenance.

### PART 3 - EXECUTION

#### 3.1 APPLICATION AND INSTALLATION:

- A. General Installation Requirements:
  - 1. After completion of painting.



2. Comply with governing regulations and requests of governing authorities for identification of electrical work.
- B. Conduit Identification:
1. Where high voltage conduit is exposed, apply identification to conduit.
- C. Underground Cable and Duct Identification:
1. During back-filling of underground cable or duct, install continuous marker warning tape, directly over buried line 6" to 12" below finished grade. Where multiple lines are buried in common trench not exceeding 24" width, install a single line marker.
  2. Install line marker warning tape for every buried ductbank.
- D. Operational Identification and Warnings:
1. Provide operational signs for main switch.
- E. Danger Signs:
2. Provide as required by Codes.
- F. Engraved Plastic Laminated Signs: Install on each major unit of electrical equipment in the building. Provide single line of text, 1/4" high lettering on 1" high sign (1-1/2" high where 2 lines required). Matching terminology and numbering of contract documents. Provide signs for each unit of the following categories (signs shall identify item fed, voltage where fed from):
1. Electrical cabinets and enclosures. Indicate voltage.
  2. Access panel/doors to electrical facilities.
  3. Major electrical switchgear (indicate voltage).
  4. Electrical substations.
  5. Safety switches and circuit breakers.
  6. Transformers.
  7. Feeders in pull and junction boxes and in all switchgear. Fasten with nylon ties.
  8. All equipment furnished in this Division of the specifications.
  9. Install signs where indicated or most visible. Secure with screws or epoxy adhesive. Secure to feeder cables with nylon ties.
  10. Nameplate sign shall include system voltage and source of feed (where applicable).
- G. Outlet pull, and junction boxes shall be identified with circuit number(s), and source panel or switchgear/switchboard indicated with legible text written with permanent black marker. Write text and box cover.
- H. Branch circuit and feeder conductors shall be identified where they enter pullboxes, switchgear, switchboards, panelboards, transformers, and handholes. Feeder identification shall include source, conductor size, and phase identification.
- I. Provide engraved device plates for wiring devices where indicated on drawings or related sections of the specifications.
1. Use black letters for devices on normal circuits; use red letters for essential circuits.

END OF SECTION 260553

## SECTION 260923 - LIGHTING CONTROL DEVICES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following lighting control devices:
  - 1. Switch-box occupancy sensors.
  - 2. Indoor occupancy sensors.
  - 3. Wallbox-style dimmers.
- B. Related Sections include the following:
  - 1. Section 262726 "Wiring Devices" for manual light switches.

#### 1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.

### PART 2 - PRODUCTS

#### 2.1 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

- A. Line-Voltage Surge Protection: An integral part of the devices for 120- and 277-V solid-state equipment. For devices without integral line-voltage surge protection, field-mounting surge protection shall comply with IEEE C62.41 and with UL 1449.

## 2.2 INDOOR OCCUPANCY SENSORS

- A. Switch Box Sensors: PIR type with integral power-switching contacts rated for 800 W at 120-V ac, suitable for incandescent light fixtures, fluorescent light fixtures with magnetic or electronic ballasts, or 1/6-hp motors; (rated for 1000 W at 277-V ac).
1. Approved product: Wattstopper WI-200
- B. Wall- or ceiling-mounting, sensor.
1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
  2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit. Sensor shall include auxiliary single-pole, double-throw isolated relay.
  3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
  4. Mounting:
    - a. Sensor: Suitable for mounting in any position on a standard outlet box.
    - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
    - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door or coverplate.
  5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
  6. Bypass Switch: Provide manual OFF/ON function facilitated by installation of a momentary contact switch.
    - a. Approved Bypass Switch: Wattstopper LVS-1 or approved equal.
- C. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
1. Detector Sensitivity: Detect occurrences of 6-inch (150-mm) minimum movement of any portion of a human body that presents a target of at least 36 sq. in. (232 sq. cm).
  2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
  3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27 m) when mounted on a 10-foot- (3-m-) high ceiling.
  4. Approved Product: Wattstopper CI-300I (ceiling) CX-100 (Wall).
- D. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.
1. Detector Sensitivity: Detect a person of average size and weight moving at least 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
  2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
  3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on an 8-foot- (2.4-m-) high ceiling.

4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
  5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).
  6. Approved Product: Wattstopper UT-300.
- E. Dual-Technology Type: Wall or Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on and off functions shall be selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
  2. Detector Sensitivity: Detect occurrences of 6-inch (150-mm) minimum movement of any portion of a human body that presents a target of at least 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving at least 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
  3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
  4. Approved Product: Wattstopper DT-300 (ceiling) or DT-200 (wall).
- F. Approved Occupancy Sensor Manufacturers: Leviton, Hubbell, Novitas, Sensor Switch, or Wattstopper.

### 2.3 WALLBOX-STYLE DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters.
1. Control: Continuously adjustable slider; with single-pole or three-way switching to suit connections.
  2. Incandescent Lamp Dimmers: Modular, 120V, 60 Hz with continuously adjustable slider; single pole with soft tap or other quiet switch; EMI/RFI filter to eliminate interference; and 5-inch (130-mm) wire connecting leads.
  3. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 1% of full brightness (depending on ballast-type).
  4. Approved Manufacturers:
    - a. Lutron, Nova-T series.
- B. Dimming Modules: Multiple channel 1920 watts min./circuit controlled by single dimming station.
1. Approved Manufactures:
    - a. Lutron, HI Power Series.

### 2.4 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG.

- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 18 AWG.
- C. Class 1 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 16 AWG.
- D. Provide unshielded, twisted-pair cable for control and signal transmission conductors.

## PART 3 - EXECUTION

### 3.1 SENSOR INSTALLATION

- A. Install according to manufacturer's instructions. Install and aim sensors in locations to achieve at least 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
- B. Do not install ultrasonic or dual-technology occupancy sensors closer than 4 feet from air supply outlets / diffusers.

### 3.2 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low Voltage Conductors and Cable." Minimum conduit size shall be 1/2 inch (13 mm).
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.
- C. Provide field-mounting transient voltage suppressors for lighting control devices locations that do not have integral line-voltage surge protection.
- D. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

### 3.3 IDENTIFICATION

- A. Identify components and power and control wiring.
- B. Label time switches and contactors with a unique designation. Provide a typewritten directory identifying circuits and spaces controlled by contactors.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test in compliance with manufacturer recommendations.
  - 2. Operational Test: Verify actuation of each sensor and adjust time delays per Manufacturer's instructions.
- B. Remove and replace lighting control devices where test results indicate that they do not function properly.
- C. Additional testing and inspecting, at Contractor's expense, may be performed to determine compliance of work with specified requirements.

3.5 ADJUSTING

- A. Occupancy Sensor Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

END OF SECTION 260923

## SECTION 260926 - LIGHTING CONTROL 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: Lighting controls using electrically operated circuit breakers.
- B. Related Requirements:
  - 1. Section 260923 "Lighting Control Devices" for field-mounted photoelectric switches, occupancy sensors, and motion sensors.
  - 2. Section 260936 "Multi-Preset Dimming Controls" for daylight harvesting control components.

#### 1.3 DEFINITIONS

- A. BAS: Building automation system.
- B. IP: Internet protocol.
- C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- D. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- E. PC: Personal computer; sometimes plural as "PCs."
- F. RS-485: A serial network protocol, similar to RS-232, complying with TIA-485-A.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, manual switches and plates, and conductors and cables.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

- B. Shop Drawings: For each lighting control panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
  - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
  - 3. Detail bus configuration, current, and voltage ratings.
  - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
  - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 6. Include diagrams for power, signal, and control wiring.
  - 7. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
  - 1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
  - 2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the network protocol.
- B. Qualification Data: For testing agency.
- C. Field quality-control reports.
- D. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.
- E. Sample Warranty: For manufacturer's special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.
- B. Software and Firmware Operational Documentation:
  - 1. Software operating and upgrade manuals.
  - 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
  - 3. Printout of software application and graphic screens.
  - 4. Device address list.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Handle and prepare panelboards for installation according to NEMA PB 1.1.



## 1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Ten (10) years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
  - 1. Eaton Corporation.
  - 2. General Electric Company.
  - 3. Lithonia Lighting; Acuity Brands Lighting, Inc.
  - 4. Siemens Energy & Automation, Inc.
  - 5. Square D.
  - 6. Lutron.
  - 7. Leviton.
- B. Source Limitations: Obtain lighting controls and power distribution components from single manufacturer.

### 2.2 SYSTEM DESCRIPTION

- A. Input signal from field-mounted or on-board signal source shall open or close one or more electrically operated circuit breakers in the lighting control panelboards. Any combination of inputs shall be programmable to any combination outputs.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with 47 CFR, Subpart A and Subpart B, for Class A digital devices.

### 2.3 PANELBOARDS

- A. The lighting panelboards may contain remotely operated circuit breakers and standard branch circuit breakers specified in Section 262416 "Panelboards."
- B. Assemblies: Comply with UL 67 and NEMA PB 1.
- C. Surge Protective Device: Integrally mounted, complying with UL 1449 Type 1.
  - 1. Comply with IEEE C62.41, Category C, 120-kA short-circuit current rating.
  - 2. Non-modular type with the following features and accessories:
    - a. Digital-display indicator lights for power and protection status.
- D. Enclosures: Comply with UL 50 and NEMA 250.

- E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- F. Panelboard Short-Circuit Current Rating: Fully rated to interrupt 22-kA symmetrical short-circuit current available at terminals.
- G. Panelboards shall have a UL-listed interrupting rating of 22-kA, sufficient for the application, or a UL-listed, series-connected rating for the maximum available fault current at that point in the system.

## 2.4 CIRCUIT BREAKERS

- A. Remotely operated branch circuit breakers used for lighting control shall provide branch-circuit overcurrent protection.

## 2.5 CONTROLLERS

- A. Description: Controllers shall contain the power supply and electronic control for operating and monitoring remotely operated branch circuit breakers.
  - 1. Comply with UL 916; with a microprocessor-based, solid-state, 365-day timing and control unit.
  - 2. Power Supply: Powered from the panelboard, sized to provide control power for the operation of the remotely operated circuit breakers, controller, bus system, low-voltage inputs, field-installed occupancy sensors, and low-voltage photo sensors.
  - 3. Integral keypad and digital-display front panel for local setup, including the following:
    - a. Blink notice, time adjustable from software.
    - b. Ability to log and display remotely operated breaker on-time.
    - c. Capability for accepting downloadable firmware so that the latest production features may be added in the future without replacing the module.
  - 4. Nonvolatile memory shall retain all setup configurations. After a power failure, the controller shall automatically reboot and return to normal system operation.
  - 5. Ethernet Communications: Comply with ASHRAE 135 protocols.
    - a. Each input connected to the controller shall control any remotely operated breaker in any other networked lighting control panel.
    - b. A schedule programmed at one controller shall be able to control any remotely operated breaker in any other networked lighting control panel.
  - 6. Time Synchronization: The timing unit shall be updated not less than every 24 hours with the network time server.
  - 7. Web Server: Display information listed below over a standard Web-enabled server for displaying information over a standard Web browser.
    - a. A secure, password-protected login screen for modifying operational parameters, accessible to authorized users via Web page interface.
    - b. Separate Web page, showing status of each main and slave lighting control panel with the arrangement of breakers on the page matching the physical appearance of the panel. Status shall include breaker nametags, pole configuration, location in panel, actual contact state (on-off/tripped/manual), and breaker on-time and blink information in real time.

- c. Panel summary showing the master and slave panels connected to the controller.
  - d. Controller diagnostic information.
  - e. Show front panel mimic screens for setting up controller parameters, input types, zones, and operating schedules. These mimic screens shall also allow direct breaker control and zone overrides.
8. Alarm and E-mail Notification: Automatically initiate alarms based on preconfigured conditions listed below and routing alarm alerts as set at the control panel.
- a. General Alarms: Power loss, non-responding breakers, loss and restoration of sub-net communications, loss and restoration of serial port communications, loss and restoration of BAS commands.
  - b. Specific Alarms: Input status, zone status, breaker status on-time (0 to 99999 hours).
  - c. E-mail Notification: Automatically route e-mail messages to five individual e-mail addresses. Within the body text of the e-mail, include a link that automatically redirects the user to the associated panels' status Web page.

B. Timing Unit:

- 1. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
- 2. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
- 3. Sixteen (16) independent schedules, each having twenty four (24) time periods.
- 4. Schedule periods settable to the minute.
- 5. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
- 6. Thirty two (32) special date periods.

C. With sixteen (16) inputs, each configurable to the following parameters:

- 1. Normally open, normally closed, two-wire maintained toggle, two-wire momentary toggle, two-wire momentary on, two-wire momentary off, or three-wire momentary operation.
- 2. On and off-delay timers for local override operation, adjustable from five minutes to 12 hours. Local override shall be by field-installed, two-wire momentary toggle switch.

## 2.6 CONTROL NETWORK

- A. Panel Controllers: Networked with other lighting control panel controllers in a peer-to-peer configuration using Ethernet 10Base-T network.
- B. Compliance with ASHRAE 135: Controllers shall support serial MS/TP and Ethernet IP communications, and shall be able to communicate directly via BAS RS-485 serial networks and Ethernet 10Base-T networks as a native device.

## 2.7 MANUAL SWITCHES AND PLATES

- A. Keypads: Programmable, designed to control lighting applications and functions associated with the equipment of this Section. The units shall be able to control any system output device, including remotely operated circuit breakers, relays, dimmers, and analog outputs.
- B. Push-Button Switches: Modular, momentary-contact, low-voltage type.
  - 1. Match color specified in Section 262726 "Wiring Devices."

- C. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Section 262726 "Wiring Devices."
- D. Wall Plates: Single and multi-gang plates as specified in Section 262726 "Wiring Devices."
- E. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

## 2.8 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG. Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Class 2 and Class 3 Control Cables: Multiconductor cable with copper conductors not smaller than No 18 AWG. Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No 18 AWG. Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, Category 6 for horizontal copper cable. Comply with requirements in Section 27 1500 "Communications Horizontal Cabling."

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
  - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
  - 2. Comply with requirements for raceways and boxes specified in Section 26 0533 "Raceways and Boxes for Electrical Systems."

- C. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

### 3.3 PANELBOARD INSTALLATION

- A. Comply with NECA 1.
- B. Install panelboards and accessories according to NEMA PB 1.1.
- C. Mounting Height: 90 inches (2286 mm) to top of trim above finished floor unless otherwise indicated.
- D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- E. Install filler plates in unused spaces.

### 3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- C. Create a directory to indicate loads served by each circuit; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are unacceptable.
- D. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.

- b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
- c. Instruments and Equipment:
  - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

C. Acceptance Testing Preparation:

- 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
- 2. Test continuity of each circuit.

D. Panelboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

### 3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

- 1. Complete installation and startup checks according to manufacturer's written instructions.
- 2. Confirm correct communication wiring, initiate communications between panels, and program the lighting control system according to approved zone configuration schedules, time-of-day schedules, and input override assignments.

### 3.7 ADJUSTING

A. Occupancy Adjustments: When requested within twelve (12) months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to one (1) visit to Project during other-than-normal occupancy hours for this purpose.

### 3.8 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two (2) years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two (2) years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

- 1. Upgrade Notice: At least thirty (30) days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain control modules.

END OF SECTION 260926

SECTION 260936 - MULTI-PRESET DIMMING CONTROL SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Contractor shall provide a complete architectural lighting control system as indicated on the drawings and specified herein.

1.2 SUBMITTALS:

- A. Submit manufacturer's standard catalog data on all products and provide complete application, wiring, and installation information on components and sub-systems. Provide one-line diagrams, dimmer schedules and control schedules.
- B. Provide test data and/or samples as required to demonstrate conformance with Part 2 of this specification.

1.3 QUALITY ASSURANCE:

- A. Manufacturer shall have a minimum of ten (10) years continuous experience in manufacturing architectural lighting control products.
- B. All devices shall be U.L. and CSA Listed specifically for the required loads (i.e., incandescent, fluorescent, magnetic low voltage transformer). Universal-type dimmers shall not be acceptable.

1.4 ACCEPTABLE MANUFACTURERS:

- A. Lutron Electronics Co., Inc., Leviton / Macro, Acuity Brands.

PART 2 - PRODUCTS

2.1 PANELS:

- A. Panels shall be surface mounted NEMA grade, constructed of sheet steel plates not less than #18 U.S. gauge. Contractor shall reinforce wall as required for wall-mounted panels. Panel shall be dead front construction.
- B. Panels shall be completely pre-wired by the manufacturer. The contractor shall be required to provide input feed wiring, load wiring, and control wiring. No other wiring or assembly by the contractor shall be permitted.
- C. Panels shall be capable of continuous operation within an ambient temperature range of 0EC (32EF) to 40EC (104EF).



- D. Panel shall provide capability to electronically assign each circuit to any zone in the dimming system. Panels using mechanical switches, rewiring, or EPROMS shall not be acceptable.
- E. Multiple panels shall be capable of operating in one system, up to a maximum of 32 panels and 768 dimmers.

## 2.2 DIMMING MODULES:

- A. Quantities of dimmer modules shall be provided to control each type of load shown on the load schedule and/or the drawings.
- B. A relay shall be employed with each dimmer to ensure that the load circuits are open when the "off" function is selected at a control station.
- C. All dimmers shall be voltage regulated so nominal change in line voltage shall not cause a perceptible change in output voltage.
- D. Provide branch circuit protection for each dimming module. Branch circuit breakers shall have the following performance characteristics:
  - 1. Be U.L. listed under U.L. 489 as a molded case circuit breaker for use on lighting circuits.
  - 2. Contain a visual trip indicator and shall be rated at 10,000 AIC.
  - 3. Circuit breakers shall be rated for tungsten loads with in rush rating no less than 20 items normal current.
  - 4. Circuit breakers shall be 100% switching duty (SWD) rated.
- E. Each dimmer shall incorporate an electronic "soft-start" default at initial turn-on that smoothly ramps the lights up to the appropriate levels within 0.5 seconds.
- F. Filtering shall be provided in each dimmer so that current rise time shall be at least 350:sec at dimmer full load measured at worst case slew rate from 10-90% of the load current waveform.
- G. Dimmer output voltage shall be a minimum 95% of input voltage at maximum intensity setting.
- H. Dimmers shall operate the following sources / load types with smooth continuous Square Law dimming curve. Dimmers shall also be capable of operating these sources on a non-dim basis. Universal-type dimmers that do not adjust the dimming curve shall not be acceptable.
  - 1. Incandescent, Tungsten and Magnetic Low Voltage Transformer
    - a. Dimmers shall contain circuitry to control dioded lamps.
  - 2. Electronic Low Voltage Transformer
  - 3. Fluorescent Electronic Dimming Ballasts
  - 4. LED (forward and reverse phase)
  - 5. Non-Dim
- I. Minimum light levels shall be user adjustable for each dimmer to compensate for individual dimmer loading.
- J. Maximum light levels shall be user adjustable for each dimmer to predetermine energy and potential lamp life savings.

## 2.3 CONTROL:

### A. General:

#### 1. Definitions:

- a. A "scene" or "preset" is a specific look or mood created by different lighting zones set at different intensities. A "zone" is one or more lighting circuits which are controlled together as a group.

2. The dimming system shall utilize a microprocessor-based, solid-state, digital processor to provide multi-scene lighting control. Each dimmer circuit shall be controlled individually or as a group or "zone" and may be digitally re-assigned or "patched" to another zone without re-wiring. Controls and dimmers are linked via a digital control network.
3. User-input control stations shall be connected together with a digital control network.
4. Wiring from dimming panel to preset dimming control and accessory controls shall be low voltage type Class 2 wiring.
5. In the event of a control station failure or interruption of a communication line to any of the controls, the dimmer(s) controlled by those stations shall remain at their current levels. The complete control system shall have a full internal battery backup that can store all system memory for one (1) year without power. System shall automatically re-boot upon restoration of normal power. The main processor shall be protected by an integral isolation transformer and shall meet the ANSI/IEEE specification for transient protection (Ref. 2.03 a1).

### B. Multiple Scene Preset Control:

1. Where indicated on the drawings, control shall provide ability to select preset lighting scenes and off. Fade time, between 0 seconds-60 minutes shall be separately selectable for each scene.

### C. Multiple Area Centralized Control:

1. Where indicated on the drawings, control shall provide preset lighting scenes for up to 384 zones in any combination of groups or areas. System set up shall be via personal computer running WINDOWS. System set up shall provide capability to:
  - a. Assign dimmers to specific zones
  - b. Determine the number of areas
  - c. Define the number of zones (up to 16) and
  - d. Scenes per area (up to 24)
  - e. Define wallstation functionality
  - f. Set the astronomic timeclock based on longitude, latitude, and daylight savings schedule
  - g. Label all areas, zones, scenes, and wallstations
2. Operating software shall additionally provide the capability to:
  - a. View the status of all areas
  - b. Create scenes
  - c. Define timeclock schedules
  - d. Plan future events on a 12 month calendar
3. Control shall allow design of system offsite and downloading upon installation or modifications after installation. Control shall also be capable of interfacing to other

equipment via integral RS-232 interface and/or modem. Control shall be capable of operating with up to 96 wall controls. Where indicated on drawings, use accessory control (wallstation) as required.

4. An integral timeclock shall execute any of the following events: select preset scenes, lockout control stations, or unlock control stations. Commands can be in either real or astronomic (relating to sunrise/sunset) time. Timeclock shall automatically correct for daylight savings time and leap year where appropriate. There shall be a total of 10 timeclock schedules available per room or area (one per day of each week, plus three special schedules). The timeclock shall be capable of executing up to 16 different events per 20 day. The timeclock can be enabled or disabled for any area via either the set up computer or local accessory control.

D. Accessory Control Options:

1. Provide the following controls for use with the preset control(s) as shown on the drawings:
  - a. Two Scene Entrance Control(s).
  - b. Four Scene Present Control: shall be capable of recalling any one of four scenes, master raise/lower and Off. Control shall provide access up to sixteen (16) scenes.
  - c. Fine Tuning Control: the temporary override of a particular zone or zones from the preset light level.
  - d. Wireless Infrared Transmitter: capable of recalling any one of four preset scenes and Off. In addition, a master raise / lower shall be provided.
  - e. Equipment Interface: capable of allowing access to preset dimming control(s) via isolated momentary/maintained dry contact closures.
  - f. Infrared Partition Sensors.
  - g. ECO Buss dimming interface.

2.4 EMERGENCY POWER TRANSFER:

- A. The dimming system shall provide a means of sensing a loss of normal power and subsequently override dimmer setting(s) of selected loads to full ON, upon activation of stand-by power source.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Install equipment per approval manufacturer's shop drawings in accordance with specifications.
- B. Electrical Contractor shall run separate neutrals for all branch load circuits.
- C. Where a dimming panel installation is complete, the electrical contractor shall completely test all line voltage power and low voltage control wiring for continuity and accuracy of connections. Prior to systems commissioning, the system shall be free of wiring defects.
- D. Manufacturer shall provide access to qualified personnel able to address problems with the dimming system.

3.2 SYSTEM COMMISSIONING:

- A. Upon completion of the installation, the system shall be completely commissioned by a Factory-trained Technician. The commissioning will be performed upon notification by the electrical contractor that the system installation is complete and that all loads have been tested live for continuity and freedom from defects and that all control wiring has been connected and checked for proper continuity. The electrical contractor shall provide both the manufacturer and the Architect with ten working days notice of the scheduled commissioning date.
- B. Upon completion of the system check-out, the technician shall demonstrate the operation of the system to appropriate owner's representatives allowing a minimum of 8 hours instruction.

3.3 WARRANTY AND WARRANTY SERVICE:

- A. Manufacturer shall provide a one (1) year warranty on complete system for all systems without factory commissioning. Warranty covers 100% of cost of manufacturer's services and replacement parts required first year attributable to the Manufacturer.
- B. Warranty coverage shall begin from date of final system commissioning. Commissioning and warranty service shall be performed by a factory-trained technician.

END OF SECTION 260936

## SECTION 261116 - SECONDARY UNIT SUBSTATIONS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes indoor secondary unit substations, each consisting of the following:
  - 1. Primary incoming section.
  - 2. Transformer.
  - 3. Secondary distribution section.
- B. Unit Substations are owner furnished, contractor installed.

#### 1.3 DEFINITIONS

- A. NETA ATS: Acceptance Testing Specification.

#### 1.4 INFORMATIONAL SUBMITTALS

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

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For secondary unit substations and accessories to include in emergency, operation, and maintenance manuals. Assemble data supplied with owner furnished equipment and submit for close-out records.

#### 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
  - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of secondary unit substations and are based on the specific system indicated. Refer to Section 016000 "Product Requirements."
- C. 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.

- D. Comply with IEEE C2.
- E. Comply with IEEE C37.121.
- F. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.
- B. Coordinate delivery of secondary unit substations to allow movement into designated space.
- C. Store secondary unit substation components protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.
- D. Handle secondary unit substation components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.8 PROJECT CONDITIONS

- A. Field Measurements: Indicate measurements on Shop Drawings.
- B. Interruption of Existing electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  - 1. Notify Owner's Representative no fewer than seven days in advance of proposed interruption of electric service. All tie-ins and connections shall be scheduled during the plant shutdown in July.
  - 2. Do not proceed with interruption of electric service without Owner's written permission. Assume holiday and "round the clock" work.
- C. Service Conditions: IEEE C37.121, usual service conditions, except for the following:
  - 1. Exposure to significant solar radiation.
  - 2. Altitudes above 3300 feet.
  - 3. Exposure to fumes, vapors, or dust.
  - 4. Exposure to explosive environments.
  - 5. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
  - 6. Exposure to seismic shock or to abnormal vibration, shock, or tilting.
  - 7. Exposure to excessively high or low temperatures.
  - 8. Unusual transportation or storage conditions.
  - 9. Unusual grounding resistance conditions.
  - 10. Unusual space limitations.

1.9 COORDINATION

- A. Coordinate layout and installation of secondary unit substations with other construction that penetrates floors and ceilings, or is supported by them, including light fixtures, HVAC equipment, and fire-suppression-system components.

- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- 1. Unit substations as manufactured by:
  - a. Schneider Electric
  - b. Eaton / Westinghouse / Cutler hammer
  - c. Seimens

### 2.2 MANUFACTURED UNITS

- A. Indoor Unit Arrangement: Single assembly.

### 2.3 INCOMING SECTION

- A. Primary Incoming Section: Enclosed, air-interrupter, primary switch.
  - 1. Three pole, single throw, dead front, metal enclosed, with manual stored energy operator, with fuses mounted on a single frame, complying with IEEE C37.20.3.
  - 2. Key interlocking system to prevent fuse access door from being opened unless switch is open. Additionally, interlock air-interrupter switch with transformer secondary main circuit breaker, preventing switch from being opened or closed unless secondary main circuit breaker is open on 480 V units.
  - 3. Continuous-Current Rating: 600 A.
  - 4. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading. Comply with the following:
    - a. Current-limiting type, rated for not less than 50-kA RMS symmetrical current-interrupting capacity.
- B. Surge Arresters: Comply with IEEE C62.11, Distribution class; metal-oxide-varistor type, with ratings as indicated, connected in each phase of incoming circuit and ahead of any disconnecting device.

### 2.4 SECONDARY DISTRIBUTION SECTION

- A. 480V Secondary Distribution: Low-voltage switchgear.

### 2.5 IDENTIFICATION DEVICES

- A. Compartment Nameplates: Engraved, laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

### 2.6 SOURCE QUALITY CONTROL

- A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90. Conduct switchgear and switchboard tests according to ANSI C37.51.

- B. Factory Tests: Perform the following factory-certified tests on each secondary unit substation:
1. Resistance measurements of all windings on the rated voltage connection and on tap extreme connections.
  2. Ratios on the rated voltage connection and on tap extreme connections.
  3. Polarity and phase relation on the rated voltage connection.
  4. No-load loss at rated voltage on the rated voltage connection.
  5. Exciting current at rated voltage on the rated voltage connection.
  6. Impedance and load loss at rated current on the rated voltage connection and on tap extreme connections.
  7. Applied potential.
  8. Induced potential.
  9. Temperature Test: If a transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class FA rating.
    - a. Temperature test is not required if a record of a temperature test on an essentially duplicate unit is available.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Contractor shall obtain shop drawings and installation instructions from the Owner and review and follow for receipt, handling, and installation.
- B. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of work.
- C. Examine roughing-in of conduits and grounding systems to verify the following:
1. Wiring entries comply with layout requirements.
  2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
- D. Examine walls, floors, roofs, and concrete bases for suitable conditions for secondary unit substation installation.
- E. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at secondary unit substation location.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install secondary unit substations on concrete bases.
1. Anchor secondary unit substations to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
  2. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit and 4 inches high.



3. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3.
4. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
5. Install epoxy-coated anchor bolts for anchoring equipment to the concrete base.
6. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Bolt transformers to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.

- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

### 3.3 IDENTIFICATION

- A. Identify field-installed wiring and components and provide warning signs as specified in Section 260553 "Identification for Electrical Systems."
- B. Operating Instructions: Frame printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of secondary unit substation.

### 3.4 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.5 CLEANING

- A. After completing equipment installation and before energizing, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections.

### 3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Schedule and coordinate a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Testing: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- C. Perform the following field tests and inspections and prepare test reports:
1. Perform each visual and mechanical inspection and electrical test according to NETA ATS. Certify compliance with test parameters.
  2. After installing secondary unit substation but before primary is energized, verify that grounding system at the substation tested at the specified value or less.
  3. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.

4. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
  - a. Remove and replace malfunctioning units and retest as specified above.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel and adjust, operate, and maintain systems.

END OF SECTION 261116

## SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
  - 1. Distribution transformers.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Wiring Diagrams: Power, signal, and control wiring.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

#### 1.5 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Sector; Eaton Corporation; Cutler-Hammer Products.
  2. General Electric Company.
  3. Hammond Co.
  4. Magnetek Power Electronics Group.
  5. Myers Power Products, Inc.
  6. Siemens Energy & Automation, Inc.
  7. Sola/Hevi-Duty.
  8. Square D Co./Groupe Schneider NA; Schneider Electric.

## 2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
1. Internal Coil Connections: Brazed or pressure type.
  2. Coil Material: Copper.

## 2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Enclosure: Ventilated, NEMA 250, Type 2.
1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Transformer Enclosure Finish: Comply with NEMA 250.
1. Finish Color: Gray.
- E. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- F. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- G. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

- H. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:
  - 1. 9 kVA and Less: 40 dBA
  - 2. 30 to 50 kVA: 45 dBA
  - 3. 51 to 150 kVA: 50 dBA
  - 4. 151 to 300 kVA: 55 dBA
  - 5. 301 to 500 kVA: 60 dBA

## 2.4 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 0553 "Identification for Electrical Systems."

## 2.5 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 26 0526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions and requirements in Section 26 0529 "Hangers and Supports for Electrical Systems."

### 3.3 CONNECTIONS

- A. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Perform tests and inspections and prepare test reports.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- D. Remove and replace units that do not pass tests or inspections and retest as specified above.
- E. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
  - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
  - 2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
  - 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- F. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

### 3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

### 3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

## SECTION 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 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
  - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
  - 3. Detail bus configuration, current, and voltage ratings.
  - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
  - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 6. Include wiring diagrams for power, signal, and control wiring.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Field Quality-Control Reports:
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

## 1.5 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 Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

## 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. Keys: Two (2) spares for each type of panelboard cabinet lock.

## 1.7 QUALITY ASSURANCE

- A. 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.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

## 1.9 PROJECT CONDITIONS

- A. Environmental Limitations:
  - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.



2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - a. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
  - b. Altitude: Not exceeding 6600 feet (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).

## 1.10 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

## 1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five (5) years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Flush- and surface-mounted cabinets.
1. Rated for environmental conditions at installed location.
    - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
    - b. Outdoor Locations: NEMA 250, Type 3R.
    - c. Kitchen or Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
    - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
  2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
  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: Same finish as panels and trim.

4. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
- B. Incoming Mains Location: Top and bottom.
- C. Phase, Neutral, and Ground Buses:
1. Material: Tin-plated aluminum.
  2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
  3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
  4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
  5. Split Bus: Vertical buses divided into individual vertical sections.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Tin-plated aluminum.
  2. Main and Neutral Lugs: Compression type.
  3. Ground Lugs and Bus-Configured Terminators: Compression type.
  4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  5. Subfeed (Double) Lugs: Compression type, suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
  6. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

## 2.2 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  3. Siemens Energy & Automation, Inc.
  4. Square D; a brand of Schneider Electric.
- C. Panelboards: NEMA PB 1, power and feeder distribution type.

- D. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
  - 1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.
- E. Mains: Circuit breaker and Lugs only.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

### 2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 3. Siemens Energy & Automation, Inc.
  - 4. Square D; a brand of Schneider Electric.
- C. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- D. Mains: Circuit breaker or lugs only.
- E. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- G. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

### 2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 3. Siemens Energy & Automation, Inc.
  - 4. Square D; a brand of Schneider Electric.
- C. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
  - a. Instantaneous trip.
  - b. Long- and short-time pickup levels.
  - c. Long- and short-time time adjustments.
  - d. Ground-fault pickup level, time delay, and  $I^2 t$  response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
  - a. Standard frame sizes, trip ratings, and number of poles.
  - b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
  - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
  - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
  - e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
  - f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
  - g. Auxiliary Contacts: One SPDT switch, with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
  - h. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
  - i. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
  - j. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
  - k. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
  - l. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
  - m. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

## 2.5 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.
- C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- D. Install overcurrent protective devices and controllers not already factory installed.
  - 1. Set field-adjustable, circuit-breaker trip ranges.
- E. Install filler plates in unused spaces.
- F. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
- G. Comply with NECA 1.

#### 3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- D. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
    - c. Instruments and Equipment:
      - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- E. Panelboards will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.5 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. Wiring devices and plates (receptacles, switches, Floor service outlets, poke-through assemblies, and multi-outlet assemblies) and their installation.
- B. Related Sections:
  - 1. Section Division 260923 "Lighting Control Devices"
  - 2. Division 27 and 28.

1.2 DEFINITIONS:

- A. EMT: Electromagnetic interface
- B. GFCI: Ground-fault circuit interrupter
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor
- D. RFI: Radio-frequency interference
- E. UTP: Unshielded twisted pair

1.3 SUBMITTALS:

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Listed legends and description of materials and process used for pre-marking wall plates
- C. Samples: One (1) for each type of device and wall plate specified in each color specified, as requested by Architect.
- D. Field-quality-control test reports.
- E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction materials that include labeling conditions.

1.4 QUALITY ASSURANCE:

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one (1) source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one (1) source.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1.5 COORDINATION:

- A. Receptacles for equipment: Match plug configurations.
  - 1. Cord and Plug Set: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, the following:
  - 1. Hubbell
  - 2. Cooper
  - 3. Pass & Seymour
  - 4. Leviton
  - 5. Wiremold / Walker

2.2 DEVICES:

- A. Furnish devices as shown in Table 1. Catalog numbers establish minimum standard of quality. Submit list of devices with catalog number proposed for review prior to ordering.
- B. Use gray color, except in special areas designated elsewhere.
- C. Special colors selected from standard available of almond, white, brown, black, or grey. Furnish color chart.
  - 1. Use red color for devices on generator power.
  - 2. Use orange color for isolated ground receptacles, or as specified above with orange triangle on face.
- D. Device Plates:
  - 1. Furnish devices with cover plates, .04" thick, type 302, stainless steel with brushed finish.
  - 2. Device plates in special areas to match device color.
  - 3. Furnish configuration of device plates required for multi-gang installations.
  - 4. Furnish weatherproof devices with individual gasketed aluminum or stainless steel covers U. L. listed for wet locations "In-Use".



### 2.3 GFI RECEPTACLES

- A. General Description: Straight blade, non-feed through type. Comply with NEMA WD 1, NEMA WD 6 UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

### 2.4 PENDANT CORD-CONNECTOR DEVICES

- A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.
  - 1. Body: Nylon with screw-open cable-gripping jaws and provision for attachment external cable grip.
  - 2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

### 2.5 CORD AND PLUG SETS:

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
  - 1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket, with green-insulated grounding conductor and equipment-rating ampacity, plus a minimum of 30 percent.
  - 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

### 2.6 SNAP SWITCHES:

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 volt, 20 amp.

### 2.7 FLOOR SERVICE FITTINGS:

- A. Type: Modular dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: round, solid brass with satin finish.
- D. Power Receptacle: NEMA WD 6 configuration 5-20R gray finish, unless otherwise indicated.
- E. Voice and Data Communication Outlet: See Division 27 and 28.

## 2.8 POKE-THROUGH ASSEMBLIES:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Incorporated; Wiring Device-Kellems
  2. Pass & Seymour / Legrand; Wiring Devices and Accessories
  3. Thomas & Betts Corporation
  4. Wiremold Company (The)
- B. Description: Factory-fabricated and factory-wired assembly of below-floor junction box with multi-channeled, through floor raceway / firestop unit and detachable matching floor service outlet assembly.
1. Service Outlet Assembly: Flush type with services indicated.
  2. Size: Selected for nominal 3-inch or 4-inch cored holes in floor and matched to floor thickness.
  3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
  4. Closure Plug: Arranged to close unused cored openings and reestablish fire rating of floor.
  5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of two (2), 4-pair, Category 6 voice and data communication cables. (See Division 27 and 28)

## 2.9 MULTI-OUTLET ASSEMBLIES:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Incorporated; Wiring Device-Kellems
  2. Wiremold Company (The)
  3. Panduit
- B. Components of Assemblies: Products from a single manufacturer designed for use as a complete matching assembly of raceways and receptacles.
- C. Raceway Material: Metal with manufacturer's standard finish.
- D. Wire: No. 12 AWG

E. TABLE 1 – BASIS-OF-DESIGN - WIRING DEVICES

DEVICE	NEMA CONF.	MANUFACTURER	CATALOG # HEAVY DUTY SPEC GRADE
Single Receptacle	5-20R	Hubbell	HBL5361
Single Receptacle	6-20R	Hubbell	HBL5461
Single Receptacle	14-20R	Hubbell	HBL8410
Single Receptacle	15-20R	Hubbell	HBL8420
Single Receptacle	5-30R	Hubbell	HBL9308
Single Receptacle	6-30R	Hubbell	HBL9330
Single Receptacle	14-30R	Hubbell	HBL9430A with 6ft. rubber cord set
Single Receptacle	6-50R	Hubbell	HBL9367 w/9368 plug
Single Receptacle	14-50R	Hubbell	HBL9450A w/ cord set
Single Receptacle	15-50R	Hubbell	HBL8450A w/ cord set
Single Receptacle	L5-20R	Hubbell	HBL2310
Duplex Receptacle	5-20R	Hubbell	HBL5362
Duplex Receptacle, Isolated Ground	5-20R IG	Hubbell	IG5362
Duplex Receptacle, GFCI, Weatherproof	5-20R GF	Hubbell	GF5362 w/ WP26M cover
Duplex Receptacle, Tamper-Proof	5-20R TP	Hubbell	HBL8300SG
Duplex Receptacle, GFCI	5-20R GF	Hubbell	GF5362
Floor Outlet with Equipment Connection	¾" NPT	Wiremold	881/881ADP-896
Floor Outlet with Duplex Receptacle	5-20R	Wiremold	881/881ADP-895/ HBL5362
Floor Outlet Double Duplex Receptacle	5-20R	Wiremold	880MP-827-(2)828R/ HBL5362
Wall Switch 1-Pole	20A,120/277V	Hubbell	CS1221
Wall Switch 2-Pole	20A,120/277V	Hubbell	CS1222
Wall Switch 3-Way	20A,120/277V	Hubbell	CS1223
Wall Switch 4-Way	20A,120/277V	Hubbell	CS1224
Wall Switch, SPDT Momentary Contact, Center OFF	20A,120/277V	Hubbell	HBL1557
Wall Switch 1-Pole, Locking Key	20A,120/277V	Hubbell	HBL1221L
Wall Switch 1-Pole, Pilot	20A,120/277V	Hubbell	HBL1221PL
Wall Switch 1-Pole Lighted Handle	20A,120/277V	Hubbell	HBL1221ILC

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
  - 1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
  - 2. Keep outlet boxes free of plaster drywall joint compound, mortar, cement, concrete dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
  - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is toweled flush with the face of the wall.
  - 4. Install wiring devices after all wall preparation, including painting is complete.
- C. Conductors:
  - 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
  - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or picking of solid wire or cutting strands from stranded wire.
  - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300 without pigtails.
  - 4. Existing Conductors:
    - a. Cut back and pigtail, or replace all damaged conductors.
    - b. Straighten conductors that remain and remove corrosion and foreign matter.
    - c. Pigtailling existing conductors is permitted provided the outlet box is large enough.
- D. Device Installation:
  - 1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
  - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
  - 3. Do not remove surface protection, such as plastic film and smudge covers, until last possible moment.
  - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
  - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
  - 6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
  - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-amp 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.

10. Devices shall be installed secure, tight, and flush to the wall surface. Install outlet box extension rings or spacers to bring device flush to surface.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: do not use oversized or extra-deep plates. Repair wall finishes and re-mount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: unless otherwise indicated, mount flush with long dimension vertical and with grounding terminals of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

H. Adjust location of floor service outlets and service poles to suit arrangement of partitions and furnishings.

### 3.2 IDENTIFICATION

I. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

2. Engraving shall be 1/4" high letters.

3. Color of letter fill corresponding to branch of electrical system:

- a. Black for Normal
- b. Red for Essential / Emergency
- c. Blue for UPS

### 3.3 FIELD QUALITY CONTROL

J. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 1436.

2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

K. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.

2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.

3. Ground Impedance: Values of up to 2 ohms are acceptable.

4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

5. Using the test plug, verify that the device and its outlet box are securely mounted.

6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 262726

## SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Fusible switches.
  - 2. Nonfusible switches.
  - 3. Receptacle switches.
  - 4. Shunt trip switches.
  - 5. Molded-case circuit breakers (MCCBs).
  - 6. Molded-case switches.
  - 7. Enclosures.

#### 1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
  - 1. Enclosure types and details for types other than NEMA 250, Type 1.
  - 2. Current and voltage ratings.
  - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
  - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Field quality-control reports.
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- C. Manufacturer's field service report.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers 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 enclosed switches and circuit breakers.

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.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
  - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NFPA 70.

## 1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
  2. Altitude: Not exceeding 6600 feet (2010 m).

## 1.10 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

## PART 2 - PRODUCTS

### 2.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  3. Siemens Energy & Automation, Inc.
  4. Square D; a brand of Schneider Electric.
- C. Type HD, Heavy Duty, Single Throw, 240- or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
  5. Lugs: Compression type, suitable for number, size, and conductor material.
  6. Service-Rated Switches: Labeled for use as service equipment.



## 2.2 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 3. Siemens Energy & Automation, Inc.
  - 4. Square D; a brand of Schneider Electric.
- C. Type HD, Heavy Duty, Single Throw, 240- or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 4. Lugs: Compression type, suitable for number, size, and conductor material.

## 2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 3. Siemens Energy & Automation, Inc.
  - 4. Square D; a brand of Schneider Electric.
- C. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- D. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- E. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

- F. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
  - 1. Instantaneous trip.
  - 2. Long- and short-time pickup levels.
  - 3. Long- and short-time time adjustments.
- G. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- H. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- I. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- J. Features and Accessories:
  - 1. Standard frame sizes, trip ratings, and number of poles.
  - 2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
  - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
  - 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
  - 5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

## 2.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
  - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
  - 2. Outdoor Locations: NEMA 250, Type 3R.
  - 3. Kitchen or Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
  - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
  - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Install fuses in fusible devices.
- C. Comply with NECA 1.

### 3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- D. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
    - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262816

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 SCOPE:

- A. Furnish and install all materials and labor required to provide a complete functional addition to the existing lightning protection and common ground system for the building as shown and detailed on the plans, in strict accordance with this section of the specifications and the applicable contract drawings.

1.2 STANDARDS AND QUALITY ASSURANCE:

- A. The following specifications and standards of the latest current issue form a part of this specification.
  - 1. N.F.P.A. - Code No. 780.
- B. All materials for this work shall be new and the standard product of a manufacturer regularly engaged in the production of lightning protection systems and shall be of the latest approved designs. Equipment shall be approved for UL listing. All materials shall be as manufactured by Thompson Lightning Protection, Inc. of St. Paul, Minnesota, Robbins, Harger, or approved equal. For approval of manufacturer other than specified, complete proposed material data and installation drawings must be submitted to Engineer for review not less than 10 days prior to bid date.
- C. In order to insure integrity of installation, the system shall be installed under the direct job site supervision of Certified Master Installer.

1.3 SHOP DRAWINGS:

- A. Complete shop drawings of the entire lightning protection system showing the type, size, mounting details, and location of all equipment, grounds and cable routings, etc., shall be submitted to the Engineer for approval prior to start of work. If any departures of consequence from the Approved Shop Drawings are deemed necessary by the Contractor, details thereof shall be submitted and approval obtained, before work is resumed and completed.

1.4 SYSTEM:

- A. System materials in general shall be copper and high copper-content bronze castings, and shall comply in weight, size, and composition for the class of structure to be protected, as specified in above mentioned Codes. The system shall consist of all necessary cables, air terminals, mounting bases, fittings, couplings, connectors, fasteners, etc., as required to give a complete and coordinated system. All cable and all air terminals shall bear proper UL labels.
- B. Supplier of system shall review all drawings to obtain all items required to be connected to system. Drawings show only main aspects of system. No extra compensation will be allowed for coverage and connectors required to meet NFPA 780.

- C. New work or extensions to existing structures: Downloads and risers to be run in 1" PVC conduit in locations shown on Shop Drawings. Down leads in steel frame buildings shall be bonded at the top and bottom. Install suitable junction boxes in conduit system for bonding taps which shall be made with full-size conductor. Rebar steel in these columns shall be lapped a minimum of 24 diameters and ties shall be installed per A.S.T.M. standards.
- D. All system fittings except cable holders, regardless of Structure classification shall be heavy-duty type made from bronze castings and secured with bolted-pressure clamps. Pressure plates made from stamped or pressed metal parts, or fittings utilizing crimp-type pressure devices will not be allowed. All bolts, screws, and related type hardware shall be stainless steel.

## PART 2 - PRODUCTS

### 2.1 MATERIALS AND EQUIPMENT:

- E. All materials shall be copper or copper alloys as described above, UL approved and labeled as required, and of the size, weight, and construction to suit the application where used in accordance with Code requirements for the Class of structure involved, and as per manufacturer recommendations.
- F. Air terminals shall be solid, 1/2" diameter round copper bar, full nickel plated, and of sufficient length to project 10" minimum above the object to be protected, and UL labeled. Locate and space points in accordance with L.P.I. requirements.
- G. Point bases shall be cast bronze with bolt-pressure cable connectors. Parapet type units shall provide for 1-1/2" coping overhand. Adhesive type bases for flat roofs shall have a minimum surface contact area of 18.5 square inches, and be secure with a proper adhesive.
- H. Conductors shall be braided smooth twist or rope-lay stranding commercially pure copper cable, sized per Code and UL labeled.
- I. Ground rods shall be 3/4" diameter and 10'-0" long copper-clad steel, connected to system downlead cable with two-bolt bronze clamp with stainless steel cap screws. Driven depth to be a minimum of 12 feet.
- J. Cable fasteners shall be substantial in construction, compatible with the conductor and mounting surfaces, and spaced according to Code requirements.
- K. Bonding devices, cable splicers, and miscellaneous connectors shall be cast bronze with bolt pressure cable connections with stainless steel hardware. Any connections between dissimilar metals shall be made with approved bi-metallic connectors or spacers.

## PART 3 - EXECUTION

### 3.1 SYSTEM DESIGN:

- A. Contractor shall have supplier of system design system in accordance with these specifications furnishing shop drawing for approval prior to foundations (footing) work.

### 3.2 INSTALLATION:

- A. All equipment and materials shall be installed in a neat workmanlike manner by skilled installers, under the direct field supervision of a Certified Master Installer who has qualified under the LPI's Certification Program or similar installation training.
- B. System installation shall be complete; including necessary cable networks on the roof for air terminals and devices, bonding networks and taps for grounding equipment and roof metals, and downlead conductors routed concealed in building structure to ground level. Where downleads and risers penetrate roofs and walls, suitable 1/2" copper rod type thru-roof connectors shall be used, equipped with necessary lead or neoprene washers and nuts for watertight seal. Copper pitch pockets shall be used at locations with built-up roofs. Adhesive-type point bases and cable holders shall be installed on build-up roof areas before application of roof gravels.
- C. System installers shall thoroughly coordinate their work with other trades to insure a correct, neat, and unobtrusive complete installation.

### 3.3 BONDING AND SYSTEM GROUNDS:

- A. A common ground shall be provided between the lightning protection system and the building electric and telephone service grounds. In addition, all underground metallic piping systems shall be bonded with full size conductor; including water, gas, sewer, fuel oil, sprinkler, and any other piping system, at points where these pipings enter the building.
- B. The building's emergency electrical service shall be provided with a set of lightning surge arresters, secondary as required. Only valve type arresters will be acceptable, either single or three-phase as required.
- C. Bonding of all metallic objects and systems at roof levels and elsewhere on the structure shall be complete. Primary bonds for metal bodies of conductance shall be bonded with appropriate fittings and full-time conductor; and shall consist of but not limited to the following: Roof exhaust fans, HVAC units with related piping ductwork, exhaust vents and any other roof piping systems, cooling towers, elevator hoist machinery supports and rails systems, window washing tracks, antenna mast for TV, radio or microwave, flag poles, roof handrails and/or decorative screens, roof ladders, skylights, metal stacks, etc. Exterior Architectural metal fascia and/or curtain walls or mullions, which extend the full height of the structure, shall also be bonded, if not inherently bonded through the building frame.
- D. Metal bodies of inductance located within six feet of a conductor or object with primary bonds, shall be bonded with secondary cable and fittings. Typical of these are: plumbing vent stacks, roof flashings, parapet coping caps, gravel guards, isolated metal building panels or siding, roof drains, down spouts, roof ventilators, exterior balcony handrails, lower level sizeable miscellaneous metals, etc.

### 3.4 SUPERVISION AND CERTIFICATION:

- A. The manufacturer's local representative shall be a Certified Master Installer and shall provide direct jobsite technical supervision to Contractor's personnel during installation to insure compliance with all Code requirements.

3.5 SHOP DRAWINGS:

- A. Shop drawing As-Built with certifications by Master Installer shall be turned over to Engineer at close out.

END OF SECTION 264113



## SECTION 264313 - SURGE PROTECTIVE DEVICES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This section describes the quality, performance, and installation of Parallel Connected, AC Power, Panel Type, Surge Protective Devices (SPDs).
- B. Related Requirements:
  - 1. Section 262413 "Switchboards" for factory-installed SPDs.
  - 2. Section 262416 "Panelboards" for factory-installed SPDs.
  - 3. Section 260526 "Grounding"

#### 1.2 CODES AND STANDARDS

- A. ANSI/IEEE Std C62.41.1™-2002, IEEE Guide on the Surge Environment in Low- Voltage (1000 V and Less) AC Power Circuits
- B. ANSI/IEEE Std C62.41.2™-2002, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
- C. ANSI/IEEE Std C62.45™ -2002, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits
- D. ANSI C84.1, American National Standard for Electric Power Systems and Equipment – Voltage Ratings (60 Hertz)
- E. ANSI/IEEE Standard 1100-2005, IEEE Recommended Practice for Power and Grounding Electronic Equipment (Emerald Book) – Clause 8.6.1
- F. National Fire Protection Association (NFPA) 70 (N.E.C.) – 2002 - Article 285
- G. ANSI/UL Standards 1449, UL 1283 Listed, CUL Listed & CE compliant "low-voltage directive."
- H. C62.62-2010 - IEEE Standard Test Specifications for Surge-Protective Devices (SPDs) for Use on the Load Side of the Service Equipment in Low Voltage (1000 Volts and less) AC Power Circuits
- I. IEEE Standard C62.72™ - 2007 – IEEE Guide for the Application of Surge-Protective Devices for Low-Voltage (1000 V or less) AC Power Circuits

#### 1.3 DEFINITIONS

- A. Inominal: Nominal discharge current.
- B. MCOV: Maximum continuous operating voltage.
- C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

- D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SPD: Surge protective device.
- H. VPR: Voltage protection rating.

#### 1.4 MANUFACTURER QUALIFICATIONS

- A. All surge suppression devices shall be manufactured by an ISO 9001-2008 certified company normally engaged in the design, development, and manufacture of such equipment, with at least 10 years of engineering experience in the design and manufacture of permanently connected SPD devices.
- B. The surge suppressor manufacturer shall provide unlimited free replacement of the entire SPD for all inoperable SPD units during the warranty period.
- C. All SPDs shall be manufactured by the same manufacturer.
- D. The listing of a manufacturer as "acceptable" does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included herein. Subject to compliance with requirements, provide products by the following manufacturers and models listed below only:
  - 1. Surge Suppression Incorporated (Advantage Series (888-212-2728))
  - 2. Emerson (Liebert) Corporation (560 & 570 Series) / 614-888-0246
  - 3. Current Technology (TG Series) / 800-238-5000
  - 4. Other pre-approved manufacturers.
    - a. Pre-Approval submittals for products by manufacturers not listed above must be submitted not less than ten (10) business days prior to bid date to allow ample engineering time for review of submitted products. Products not submitted within this timeframe will not be reviewed.
    - b. Submit proper documentation showing detailed (line-by-line) compliance with this specification. Prior approvals not received by the deadline date defined above will not be considered.
    - c. Along with the line-by-line compliance from manufacturers not listed herein, pre-approval surge suppression submittals shall include all of the items listed in Section 1.5, below.
    - d. Incomplete submittal packages will not be approved.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
  - 1. Include complete schematic data for all suppressors indicating part numbers, conductor sizes, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories, etc.

2. Dimensioned drawing of each suppressor type indicating mounting arrangement. Manufacturer's ANSI/UL 1449 listing classification page and listing number(s).
3. Manufacturer's UL 1283 listing classification page and listing number(s).
4. Certified test data documenting ANSI/IEEE C62.41-2002 performance and the ability of the device to meet or exceed all requirements of this specification. Include complete let-through voltage/measured limiting voltage test data (not Voltage Protection Rating), test graphs, and scope traces for each mode for each product submitted for Category's C, B, A (including Cat A, 2 kV, 67 A, 100 kHz ring wave at both 90 & 270 degree electrical phase angles).
5. Letter from Manufacturer stating products are in strict compliance with the recommendations of IEEE Standard 1100-2005, Clause 8.6.1 and incorporate 10 individual dedicated discrete modes of protection for three-phase Wye systems, including direct line-to-line components. (Reduced-mode variations will not be accepted).
6. Certificate of declaration that product is CE low voltage directive compliant.
7. Statement of Manufacturer's warranty duration and replacement policy.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For manufacturer's special warranty.
- C. Operation and maintenance data.

#### 1.7 CLOSEOUT SUBMITTALS

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

#### 1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.
  1. Warranty Period: Five (5) years from date of Substantial Completion.
- B. All SPD devices shall be warranted to be free from defects in materials and workmanship under normal use in accordance with the instructions provided for a period of twenty-five (25) years from date of substantial completion.
- C. Any SPD device that shows evidence of failure or incorrect operation, including damage as the result of lightning strikes, during the warranty period shall be replaced as a complete unit (not just modules, subassemblies, or components) by the manufacturer at no charge to the owner. Warranty will provide for multiple exchanges of any inoperable devices at any time during the warranty period that starts at the date of substantial completion of the system to which the surge suppressor is installed.
- D. SPD manufacturers whose warranty does not meet the requirements listed above standard shall submit a letter extending the warranty to meet these standards with the product submittal.

## 1.9 QUALITY ASSURANCE

- A. All Surge Protective Devices (SPDs) shall be tested and listed to ANSI/UL 1449-2006 by an independent testing agency, with the experience and capability to conduct the testing indicated, that is a Nationally Recognized Testing Laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction. This agency must comply with ANSI/IEEE C62.45 test procedures for all categories established in C62.41 (1991). "Manufactured in accordance with UL 1449" is not equivalent to being listed to ANSI/UL 1449 and does not meet the intention of this specification. In addition to being UL 1449 listed, Type 2 SPDs shall be Complimentary Listed to UL 1283.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. The Surge Protective Devices (SPDs) shall be of a parallel-connected design using fast-acting transient energy protection components that will divert and dissipate the surge energy.
- B. All SPDs shall be tested and listed to ANSI/UL 1449 by a Nationally Recognized Testing Laboratory (NRTL) (i.e. CSA, UL, etc.). Type 2 SPDs shall be Complimentary Listed to UL 1283.
- C. All SPDs shall be Type 2 SPDs unless otherwise directed by the specifying engineer; Type 4 SPDs are not permitted. (Definitions: Type 1 SPD – Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service equipment overcurrent device, as well as the load side, including watt-hour meter socket enclosures and intended to be installed without an external overcurrent protective device. Type 2 SPD – Permanently connected SPDs intended for installation on the load side of the service equipment overcurrent device; including SPDs located at the branch panel. Type 4 SPD – Recognized Component SPDs, including discrete components as well as component assemblies, which bear specific conditions of acceptability.)
- D. The SPD shall be tested and listed by an NRTL as a complete assembly to a symmetrical fault current rating greater than or equal to the available fault current at the location of installation at the connected panel without the need for upstream over current protection, in accordance with NEC Article 285 and shall be marked with the Short Circuit Current Rating (SCCR). If the available fault current is unknown, then the SCCR of the SPD shall be 200 kAIC. Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD, per NEC 285.6.
- E. Permanently connected devices mounted parallel to the service, distribution, and sub panels are required. SPD device drawings shall be made available upon request.
- F. The service entrance SPD shall have a Nominal Discharge Current (In) of 20 kA. All other SPDs shall have a Nominal Discharge Current (In) of 10 kA.
- G. Fusing:
  - 1. The SPD shall provide as a minimum, over-current, over temperature protection in the form of component-level thermal fusing to ensure safe failure and prevent thermal runaway. This component-level fusing shall be an integral part of the MOV itself and not silver wire (or other) independently laid across each MOV. SPDs without thermal fuses or disconnects, or SPDs with shared thermal devices that disconnect more than one MOV are not acceptable

2. Surge protective devices shall contain integral short circuit current safety fusing within each device for over-current requirements of the NEC. This fusing will be independent of the "component-level" fusing and be specifically for over-current protection and shall be constructed utilizing surge rated; cartridge fuses and not rated 'silver-fuse-wire' (or other).
3. Any SPD that is connected directly to the bus on a panel, panelboard, or MCC must have a properly sized breaker in the circuit between the SPD and the bus to permit the SPD to be serviced without the requirement to remove the power from the gear.
4. The fusing mechanisms employed must effectively coordinate their performance in conjunction with the high current abnormal over-voltage testing under ANSI/UL 1449-2006.
5. The use of any mechanical or electro-mechanical thermal / over-current protection (i.e. moving parts and/or springs and shutters) in combination with or for the protection of the suppression elements is expressly prohibited and will be rejected. Large-Block 34mm (50kA) square Thermal Protected MOVs are expressly prohibited and will not be accepted.

H. MCOV:

1. The SPD shall have a maximum continuous operating voltage (MCOV) capable of sustaining 115% of nominal RMS voltage continuously without degrading.

I. Component Limitations:

1. The SPD shall only use solid-state clamping components to limit the surge voltage and divert the surge current. SPD components that "crowbar" short-circuit the AC power system (e.g. spark gaps, gas tubes, selenium cells, or SCR's) shall not be acceptable. Device circuitry shall be bi-directional, enclosed in a UL listed encapsulated thermal stress reducing compound, and be of a parallel design.

J. Per Phase Ratings:

1. 'Per-Phase' ratings for a three-phase Wye-connected SPD are determined by multiplying the kA per mode times the number of discrete modes of protection (directly connected suppression components), minus the value for the Neutral to Ground mode, divided by the number of phases.

$$a. \quad \text{Per-Phase} = (((\text{kA per mode}) \times (\# \text{ of modes})) - (\text{N-G mode kA})) / (\# \text{ of phases})$$

K. Protection Modes:

1. The SPD system shall provide (per IEEE Std. 1100-1999 8.6.1) dedicated, independent, distinct, individual protection circuitry for every possible mode in the electrical distribution system at the point of SPD application. For example, a 277/480V, 3-phase Wye, 4-wire plus ground system has 10 distinct modes that require independent and dedicated protection (i.e., L1-L2, L2-L3, L3-L1, L1-N, L2-N, L3-N, L1-G, L2-G, L3-G, N-G). None of these modes of protection depend on protection elements purposed for other protection modes. Reduced mode SPD with only 3, 4, or 7 dedicated, distinct, independent protection modes are not acceptable and are not to be submitted. For 6 mode delta systems, 6 dedicated, independent, distinct protection modes are required (L1-L2, L2-L3, L3-L1, L1-G, L2-G, L3-G). When a mode of protection is specified, the protective mode must be specifically included. Thus, Line-to-Neutral-to-Line is not acceptable where Line-to-Line is specified.

- L. Frequency Responsive Circuitry (FRC) (a.k.a. Sinewave Tracking Capability):
1. The service entrance as well as power panels and MCCs serving sensitive electronic equipment shall utilize voltage independent, dedicated Frequency Responsive Circuitry (FRC) intended to mitigate the effects of switching or ringing surges that is specifically designed so that it can survive the surge environment. EMI/RFI filtering specifically will not be considered as equal to FRC! The performance of FRC is defined by the level to which it mitigates Ring Wave transients and can be demonstrated in the test results of IEEE C62.41.2-2002, Category A Ring Wave (2kV).
  2. To demonstrate the FRC capability of the submitted devices, manufacturers shall submit 3rd party, independent tests results for units claiming FRC capability. Such tests shall include testing under the standards of ANSI/IEEE C62.41 and C62.45 category A (2kV, 67A, 100kHz ring wave) applied at the 270 degree phase angle, positive polarity, on a 120/208Vrms, 3 phase Wye device, on each of the following modes: line-to- neutral, line-to-ground, and line-to-line (dynamic tests with normal voltage applied to the unit under test), and neutral-to-ground (static test with no normal voltage applied to unit under test). The "let-through voltage" derived from each of these tests shall have a maximum amplitude of less than 50V peak deviation from the insertion point of the surge on the sine wave to the peak of the transient. Measurement of the let-through voltage shall be made with six-inches of lead length external to the SPD housing in accordance with ANSI/UL 1449-2006. Performance requirements are as stated in the table in Section VIII below (ANSI/IEEE C62.41 Let-Through Voltage) at Test Category A1.
- M. Status Indicators:
1. SPD units shall have panel front status monitors as a minimum to indicate a continuous positive status of each protected phase. A remote audible alarm option must be supplied where the specifying engineer deems it necessary and cost effective under the circumstances. Refer to the appropriate drawings and schedules for these details.
- N. Equipment Certification:
1. Items shall be listed to ANSI/UL 1449-2006, shall bear the seal of the NRTL, shall bear the Marking "Listed to UL 1449", shall have been tested under ANSI/UL 1449-2006, and shall be marked in accordance with the referenced standard. SPD units shall be UL 1283 Listed as an Electromagnetic Interference Filter and marked accordingly. All surge suppression devices shall be manufactured by an ISO 9001-2008 certified company normally engaged in the design, development, and manufacture of such equipment.
- O. Circuit Configuration:
1. The circuit configuration of the suppression units shall be bi-directional, thermal stress reducing, encapsulated, custom parallel connected, and solid state. (Series units or units equipped with "load carrying" components are expressly prohibited due to the possibility of single point series failures causing power interruption to protected loads.)
- P. Enclosures:
1. Unless otherwise noted, provide NEMA 1 or better enclosures for indoor mounting and NEMA 4 enclosures or better for all outdoor locations. All units will contain Form C, N/O or N/C, dry relay contacts, if so specified, and weatherproof fittings to maintain the required NEMA integrity.

Q. Maintenance Restrictions:

1. No suppression unit shall be supplied which requires scheduled preventive maintenance or replacement parts. Units requiring functional testing, special test equipment, or special training to monitor surge protection device (SPD) status are not acceptable. SPD shall require NO routine maintenance. SPD devices are considered non-repairable items and shall be fully replaced upon failure.

R. Commonality:

1. All SPDs at the service entrance, distribution panels, and sub-panels shall be from the same manufacturer.

2.2 PERFORMANCE CRITERIA

A. Performance Criteria: All SPDs shall meet or exceed the following performance criteria:

1. Service Entrance (Category C):
  - a. The SPD shall provide a minimum protection of 180kA per phase (three-phase Wye), be of frequency responsive design, and be capable of meeting the Category C-High Let-Through Voltage criteria as shown in the Section VII, below.
2. Branch Panels / Panelboards (Electronics) (Category A):
  - a. The SPD shall provide a minimum protection of 120kA per phase, be of frequency responsive design, and be capable of meeting the Category A Let-Through Voltage criteria as shown in the Section 2.3, below.

2.3 ANSI / IEEE C62.41 LET-THROUGH VOLTAGE

A. The SPD shall meet the Let-Through Voltage requirements shown in the tables below for voltage and locations specified. All voltages shall be peak (+/-10%), Positive Polarity, Time base = 10µS, Sampling Rate = 500 Megasamples per second to ensure maximum transient capture. [These settings assure Let-through Voltage test results are accurate]. Surge voltages shall be measured from the insertion of the surge on the sine wave to the peak of the surge. All tests are Static (unpowered), except for the 120V circuits that are Dynamic (powered). Let-through voltages on static tests calculated by subtracting sine wave peak from let-through measured from zero. All tests shall be performed in accordance with UL 1449 -2006 with measurements performed at a point on the leads 15.24 cm (6 inches) outside of the device enclosure. No data measured at a module, lugs, component, or undefined location will be accepted. These settings assure Let-through Voltage test results are accurate. SPDs shall meet the following criteria:

1. Service Entrance ANSI/IEEE Cat. C Impulse Wave The let-through voltage based on ANSI/IEEE C62.41 and C62.45 recommended procedures for the ANSI/IEEE Cat. C (High) (10,000 amps), shall be less than (values are total let-through voltage (LTV) measured from the insertion point of the transient on the sine wave to the peak of the transient):

Mode / Voltage	120/208Y	277/480Y	480V, 3Ø Δ
L-N	1075V	1340V	N/A
L-L	1390V	1990V	1990V
L-G	1056V	1310V	2150V
N-G	1441V	1730V	N/A

2. Branch Panels/Panelboards (Electronics) ANSI/IEEE Cat. A Ring Wave Let-through-Voltage: The let-through voltage based on ANSI/IEEE C62.41 and C62.45 recommended procedures for the ANSI/IEEE Cat. A Ring Wave (2kV, 67 amps, 100 kHz ring wave) at the 270 degree phase angle, shall be less than (values are total let-through voltage (LTV) measured from the insertion point of the transient on the sinewave to the peak of the transient):

Mode / Voltage	120/208Y	277/480Y	480V, 3Ø Δ
L-N	30V	65V	N/A
L-L	40V	110V	114V
L-G	50V	85V	1605V
N-G	50V	65V	N/A

2.4 ANSI / UL 1449-2006 VOLTAGE PROTECTIVE RATING

A. Voltage Protection Rating (VPR) is a rating selected from a list of preferred values as detailed in ANSI / UL 1449-2006 and assigned to each mode of protection. The value of a VPR is determined as the nearest highest value taken from a list of preferred values (as detailed in ANSI / UL 1449-2006) compared to the measured limiting voltage determined during the transient voltage surge suppression test using the combination wave generator at a setting of 6 kV, 3 kA.



B. The SPD shall have Voltage Protection Ratings (VPRs) no greater than those shown below:

Nominal System Voltage:	Mode:	VPR:
Single-Phase 120 / 240	L-N	600 V
	L-G	600 V
	N-G	600 V
	L-L	1000 V
Three-Phase 120 / 240 Delta	L-N	600 V
	HL-N	1200 V
	L-G	600 V
	HL-G	1200 V
	N-G	600 V
	L-L	1000 V
	HL-L	1000 V
120 / 208 Wye	L-N	600 V
	L-G	600 V
	N-G	600 V
	L-L	1000 V
277 / 480 Wye	L-N	1000 V
	L-G	1200 V
	N-G	1200 V
	L-L	1800 V
480 No Neutral (Delta)	L-G	1800 V
	L-L	1800 V

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Basic principles for the installation of SPDs in electrical panels:

1. For proper performance, the SPD must be installed with the wires as short and straight as humanly possible. Any sharp bend in the wire is unacceptable! This applies to phase, neutral, and ground leads. The objective is to reduce the lengths of wire provided on each unit, not add to it. The priority is to the phase leads, then the neutral, and then the ground lead.
2. Install the breaker for the SPD close to the neutral bus, if present, on the neutral bus side of the panel. If no neutral circuit is present in the electrical panel, install the breaker close to the ground bus if possible. The ground wire should be connected to the panel by using a ground lug installed near the SPD in the can or frame as they are grounded. If necessary, once this is done, the ground wire can be extended from the lug to the ground bus if the AHJ requires this connection.
3. Install the SPD on a dedicated breaker. If the unit is piggybacked on a breaker that feeds other equipment, when that breaker is turned off to service the other equipment, you have lost the surge suppression for that panel.
4. Mount the SPD directly across from the breaker. The breaker, the neutral bus, and the SPD should be close together to keep the wires as short and straight as humanly possible. Twist the phase and neutral wires together for 2 or 3 twists per 12" of wire

between the SPD and the breaker. The phase wires should be cut short as possible and connected to the breaker with no sharp bends in the wire.

5. These same principles apply to installation on switchboards and MCCs. On MCCs, try to locate the SPD as close to the main bus as possible so that the lead lengths are short. If possible, when installing an SPD in an MCC, install it in a bucket with a feeder breaker and use a remote light mounted on the door. The Remote Light Kit (option –LP) must be ordered with the SPD. It cannot be ordered to add to the SPD as an in-the-field modification.

### 3.2 SPECIFIC INSTALLATION REQUIREMENTS

- A. Provide surge suppressor at each building service entrance and at other distribution and panelboard locations as indicated on the drawings. The SPD shall be located immediately adjacent to the switchboard or panelboard being protected (close-nipple to panel-boards). The SPD may not be located integral (switchgear manufacturer installed) within the switchboard or panelboard(s) unless the switchgear manufacturer providing such SPD products expressly meets or exceeds ALL parameters of this specification for the SPD. These SPDs shall be individually tested and Listed to ANSI/UL 1449 according to their type (Type 1 or Type 2) and not be listed solely as part of the larger assembly. SPD devices not meeting or exceeding the performance of this specification will be deemed unacceptable.
- B. Do not energize or connect service entrance equipment and panelboards to their sources until SPD devices are properly installed and connected.
- C. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.
- D. Install the SPD with #10 AWG conductors to dedicated 30-amp breaker(s) in panel per manufacturer's installation instructions and close to the Neutral Bus. The dedicated breaker shall serve as a means of service disconnect for the SPD so that the electrical panel remains energized during SPD servicing. The installer may rearrange breaker locations to ensure the shortest and straightest leads to the SPD. If a dedicated breaker is not provided, an SPD with internal 30-amp fuse or a UL Listed disconnect switch shall be installed as a minimum. The conductors (neutral and phase wires) serving the SPD shall be twisted together (2 or 3 twists per 12" of wire) to reduce the SPD system input impedance and shall be kept at the minimum length. The SPD shall be installed in strict accordance with the manufacturer's recommended practices and in compliance with N.E.C. requirements, State, and Local Codes.
- E. If any lead lengths exceed eighteen inches (18"), the Contractor responsible for installation must contact the specifying electrical engineer and the surge suppression manufacturer or distributor (888-212-2728) for installation assistance.
- F. The electrical contractor shall verify the proper application of the SPD (i.e., voltage, phases, etc.). The electrical contractor shall ensure that all Neutral conductors are bonded to the system ground at the service entrance the serving isolation transformer prior to installation of the associated SPD. The electrical contractor will ensure that neutral-to-ground bonds do not exist at locations that are not service entrances or newly derived power sources.
- G. The Electrical Contractor shall furnish all labor, materials, equipment, and services necessary for and incidental to the installation of the SPD system components as specified herein.
- H. The Electrical Contractor shall coordinate with other electrical work as necessary to interface installation of the transient voltage surge suppression systems with other work on the site.

- I. The SPD installation shall be certified by a licensed electrician that the installation is in accordance with the manufacturer's recommendations, applicable electrical code requirements and the requirements of the specification above. Any deficiencies noted shall be corrected by the Contractor. Provide written documentation of this inspection as part of the closeout documentation.
  
- J. The SPD installation must be inspected and certified by a factory-trained representative of the SPD manufacturer (888-212-2728). In completing this start-up, the factory-trained inspector shall furnish the Engineer with a letter/report stating that all devices are the correct specified model numbers, in the correct locations and designations, and installed in strict accordance with the intent of this specification and the requirements of the manufacturer. The Contractor must make the manufacturer aware of the available dates to perform this inspection and must give at least 45 (forty-five) days' notice of the required deadline date. The cost for this service must be included in the package price of the SPD device and is to be part of the construction bid package. The inspection will include one on-site visit and inspection accompanied by the report as stated above. Subsequent visits to correct problems created by the installer and not in accordance with the intent of the requirements of this specification and the installation instructions furnished by the manufacturer as noted in the report will be the ultimate responsibility of the Contractor and will be billed on a time and travel reimbursable basis until the Engineer receives final satisfactory certification from the manufacturer of the specified system.

END OF SECTION 264313

## SECTION 265100 - INTERIOR 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. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

B. Related Sections:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Section 260936 "Multi-Preset Dimming Controls".
3. Section 262726 "Wiring Devices" for manual wall-box dimmers for incandescent lamps.

#### 1.3 DEFINITIONS

- A. BF: Ballast factor.
- B. CCT: Correlated color temperature.
- C. CRI: Color-rendering index.
- D. HID: High-intensity discharge.
- E. LER: Luminaire efficacy rating.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting fixture, including ballast housing if provided.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
  1. Physical description of lighting fixture including dimensions.
  2. Emergency lighting units including battery and charger.

3. Ballast, including BF.
  4. Energy-efficiency data.
  5. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Section 233713 "Diffusers, Registers, and Grilles."
  6. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
  7. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
    - a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  2. Wiring Diagrams: For power, signal, and control wiring.
- C. Installation instructions.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Lighting fixtures.
  2. Suspended ceiling components.
  3. Partitions and millwork that penetrate the ceiling or extends to within 12 inches (305 mm) of the plane of the luminaires.
  4. Ceiling-mounted projectors.
  5. Structural members to which suspension systems for lighting fixtures will be attached.
  6. Other items in finished ceiling including the following:
    - a. Air outlets and inlets.
    - b. Speakers.
    - c. Sprinklers.
    - d. Smoke and fire detectors.
    - e. Occupancy sensors.
    - f. Access panels.
  7. Perimeter moldings.
- B. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.
- C. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.
- D. Field quality-control reports.

- E. Warranty: Sample of special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
  - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

#### 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. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
  - 2. Fluorescent-fixture-mounted, emergency battery pack: One for every twenty (20) emergency lighting unit.
  - 3. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.

#### 1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.

#### 1.9 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

#### 1.10 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Emergency Lighting Unit Batteries: ten (10) years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.

2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: seven (7) years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

### 2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- C. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- G. Diffusers and Globes:
  1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
    - a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
    - b. UV stabilized.
  2. Glass: Annealed crystal glass unless otherwise indicated.
- H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
  1. Label shall include the following lamp and ballast characteristics:
    - a. "USE ONLY" and include specific lamp type.
    - b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.

- c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
- d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
- e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
- f. CCT and CRI for all luminaires.

## 2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

### A. General Requirements for Electronic Ballasts:

1. Comply with UL 935 and with ANSI C82.11.
2. Designed for type and quantity of lamps served.
3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
4. Sound Rating: Class A.
5. Total Harmonic Distortion Rating: Less than ten (10) percent.
6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
7. Operating Frequency: 20 kHz or higher.
8. Lamp Current Crest Factor: 1.7 or less.
9. BF: 0.88 or higher.
10. Power Factor: 0.98 or higher.
11. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

### B. Luminaires controlled by occupancy sensors shall have programmed-start ballasts.

### C. Electronic Programmed-Start Ballasts for T8 Lamps: Comply with ANSI C82.11 and the following:

1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
2. Automatic lamp starting after lamp replacement.

### D. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.

1. Ballast Manufacturer Certification: Indicated by label.

### E. Ballasts for Low-Temperature Environments:

1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic-type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
2. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.

## 2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

### A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Automatic lamp starting after lamp replacement.



3. Sound Rating: Class A.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher unless otherwise indicated.
9. Power Factor: 0.98.
10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

## 2.5 EMERGENCY FLUORESCENT POWER UNIT

- A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
1. Emergency Connection: Operate two (2) fluorescent lamps continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
  2. Nightlight Connection: Operate two (2) fluorescent lamps continuously.
  3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
    - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
  4. Battery: Sealed, maintenance-free, nickel-cadmium type.
  5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
  6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
- B. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, remote mounted from lighting fixture. Comply with UL 924.
1. Emergency Connection: Operate one fluorescent lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
  2. Nightlight Connection: Operate two (2) fluorescent lamps in a remote fixture continuously.
  3. Battery: Sealed, maintenance-free, nickel-cadmium type.
  4. Charger: Fully automatic, solid-state, constant-current type.
  5. Housing: NEMA 250, Type 1 enclosure.
  6. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
  7. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
  8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

## 2.6 BALLASTS FOR HID LAMPS

- A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features unless otherwise indicated:
1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
  2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C) for single-lamp ballasts.
  3. Rated Ambient Operating Temperature: 104 deg F (40 deg C).
  4. Open-circuit operation that will not reduce average life.
  5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.
- B. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:
1. Minimum Starting Temperature: Minus 20 deg F (Minus 29 deg C) for single-lamp ballasts.
  2. Rated Ambient Operating Temperature: 130 deg F (54 deg C).
  3. Lamp end-of-life detection and shutdown circuit.
  4. Sound Rating: Class A.
  5. Total Harmonic Distortion Rating: Less than twenty (20) percent.
  6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
  7. Lamp Current Crest Factor: 1.5 or less.
  8. Power Factor: 0.90 or higher.
  9. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
  10. Protection: Class P thermal cutout.
- C. High-Pressure Sodium Ballasts: Electromagnetic type, with solid-state igniter/starter. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.
1. Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
  2. Minimum Starting Temperature: Minus 40 deg F (Minus 40 deg C).

## 2.7 QUARTZ LAMP LIGHTING CONTROLLER

- A. General Requirements for Controllers: Factory installed by lighting fixture manufacturer. Comply with UL 1598.
- B. Standby (Quartz Restrike): Automatically switches quartz lamp on when a HID lamp in the fixture is initially energized and during the HID lamp restrike period after brief power outages.
- C. Connections: Designed for a single branch -circuit connection.
- D. Switching Off: Automatically switches quartz lamp off when HID lamp reaches approximately 60 percent light output.

## 2.8 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
  - 1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
  - 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
    - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
    - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
    - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
    - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
    - f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is announced by an integral audible alarm and a flashing red LED.

## 2.9 FLUORESCENT LAMPS

- A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI 75 (minimum), and average rated life 20,000 hours unless otherwise indicated.
- B. T8 rapid-start lamps, rated 17 W maximum, nominal length of 24 inches (610 mm), 1300 initial lumens (minimum), CRI 75 (minimum), and average rated life of 20,000 hours unless otherwise indicated.
- C. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), average rated life of 10,000 hours at three hours operation per start, unless otherwise indicated.
  - 1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
  - 2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
  - 3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
  - 4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
  - 5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).

## 2.10 HID LAMPS

- A. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.
- B. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K.

## 2.11 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- B. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).
- D. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).
- E. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Lighting fixtures:
  - 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
  - 2. Install lamps in each luminaire.
- B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- C. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.
- D. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
  - 1. Install ceiling support system rods or wires; independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
  - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
  - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
- E. Suspended Lighting Fixture Support:
  - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
  - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
  - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

F. Connect wiring according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

### 3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

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

### 3.4 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

### 3.5 ADJUSTING

A. Occupancy Adjustments: When requested within twelve (12) months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to one (1) visit to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

1. Adjust aimable luminaires in the presence of Architect.

END OF SECTION 265100

## SECTION 265600 - EXTERIOR 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. Exterior luminaires with lamps and ballasts.
- 2. Poles and accessories.

- B. Related Sections:

- 1. Section 265100 "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

#### 1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. HID: High-intensity discharge.
- D. LER: Luminaire efficacy rating.
- E. Luminaire: Complete lighting fixture, including ballast housing if provided.
- F. Pole: Luminaire support structure, including tower used for large area illumination.
- G. Standard: Same definition as "Pole" above.

#### 1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
- B. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
  2. Details of attaching luminaires and accessories.
  3. Details of installation and construction.
  4. Luminaire materials.
  5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
    - a. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
  6. Ballasts, including energy-efficiency data.
  7. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
  8. Materials, dimensions, and finishes of poles.
  9. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
  10. Anchor bolts for poles.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
  3. Wiring Diagrams: For power, signal, and control wiring.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.
- B. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.
- C. Field quality-control reports.
- D. Warranty: Sample of special warranty.

## 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

## 1.8 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. Lamps: One (1) for every one hundred 100 of each type and rating installed. Furnish at least one of each type.
  - 2. Ballasts: Furnish at least one (1) of each type and rating installed.

## 1.9 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with IEEE C2, "National Electrical Safety Code."
- D. Comply with NFPA 70.

## 1.10 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch (6 mm) deep. Do not apply tools to section of pole to be installed below ground line.
- D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.
- E. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

## 1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
  - 1. Warranty Period for Luminaires: Five (5) years from date of Substantial Completion.
  - 2. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three (3) years from date of Substantial Completion.



## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

## 2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
  - 1. LER Tests Incandescent Fixtures: Where LER is specified, test according to NEMA LE 5A.
  - 2. LER Tests Fluorescent Fixtures: Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
  - 3. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.
- B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
  - 1. White Surfaces: 85 percent.
  - 2. Specular Surfaces: 83 percent.
  - 3. Diffusing Specular Surfaces: 75 percent.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

- L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- M. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
  - 1. Label shall include the following lamp and ballast characteristics:
    - a. "USES ONLY" and include specific lamp type.
    - b. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
    - c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
    - d. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
    - e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
    - f. CCT and CRI for all luminaires.

### 2.3 FLUORESCENT BALLASTS AND LAMPS

- A. Ballasts for Low-Temperature Environments:
  - 1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic-type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
  - 2. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.
- B. Ballast Characteristics:
  - 1. Power Factor: 90 percent, minimum.
  - 2. Sound Rating: Class A.
  - 3. Total Harmonic Distortion Rating: Less than ten (10) percent.
  - 4. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
  - 5. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
  - 6. Transient-Voltage Protection: Comply with IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
- C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures 0 deg F (minus 18 deg C) and higher.

### 2.4 BALLASTS FOR HID LAMPS

- A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features unless otherwise indicated:
  - 1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
  - 2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C).
  - 3. Normal Ambient Operating Temperature: 104 deg F (40 deg C).

4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

B. High-Pressure Sodium Ballasts: Electromagnetic type with solid-state igniter/starter and capable of open-circuit operation without reduction of average lamp life. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.

## 2.5 HID LAMPS

A. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and CCT color temperature 4000 K.

B. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI [80] <Insert value>, and CCT color temperature 4000 K.

## 2.6 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.

2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.

2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

F. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

## 2.7 STEEL POLES

- A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); one-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.
  - 1. Shape: Square, straight.
  - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- B. Brackets for Luminaires: Detachable, cantilever, without underbrace.
  - 1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with galvanized-steel bolts.
  - 2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
  - 3. Match pole material and finish.
- C. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- D. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.
- E. Factory-Painted Finish: 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, "Solvent Cleaning," 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, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
  - 2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
  - 3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
    - a. Color: As selected by Architect from manufacturer's full range.

## 2.8 POLE ACCESSORIES

- A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

## PART 3 - EXECUTION

### 3.1 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.

- B. Fasten luminaire to indicated structural supports.
  - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

### 3.2 POLE INSTALLATION

- A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
  - 1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
  - 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
  - 3. Trees: 15 feet (5 m) from tree trunk.
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
  - 1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
  - 2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
  - 3. Install base covers unless otherwise indicated.
  - 4. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

### 3.3 BOLLARD LUMINAIRE INSTALLATION

- A. Align units for optimum directional alignment of light distribution.
- B. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 03 3000 "Cast-in-Place Concrete."

### 3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

- A. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

### 3.5 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." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

### 3.6 GROUNDING

- A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
  - 1. Install grounding electrode for each pole unless otherwise indicated.
  - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

### 3.7 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
- C. Illumination Tests:
  - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
    - a. IESNA LM-64, "Photometric Measurements of Parking Areas."
    - b. IESNA LM-72, "Directional Positioning of Photometric Data."
- 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.

### 3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices.

END OF SECTION 265300