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BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 DESCRIPTION

- A. Perform work in accordance with regulations of serving electrical utility, telecom/broadband utility, National Electrical Code, National Electrical Safety Code, National Fire Codes, International Building Code, and other applicable codes.
- B. Whenever the requirements of the Electrical Specifications or Drawings exceed those of the applicable code or standard, the requirements of the Specifications and Drawings shall govern.
- C. This Contractor is bound by the General Conditions, Supplementary Conditions, Special Conditions, and Division 1 bound herewith in addition to this Specification and accompanying Drawings.
- D. Bidders shall view the site and shall include costs incurred by existing conditions in the bid proposal.

1.2 QUALITY ASSURANCE

- A. Materials shall be new, of manufacturer's latest design and of the best quality. The materials shall be manufactured in accordance with applicable standards of NEMA, ANSI, or UL and shall be UL listed.
- B. Complete each system as shown and place in operation except where only rough-in or partial systems are called for. Each system shall be tested and left in proper operation free of faults, shorts, or unintentional grounds.
- C. Protect electrical work, wire and cable, materials and equipment installed under this Division against damage by other trades, weather conditions, or any other causes. Equipment found damaged or in other than new condition will be rejected as defective.

1.3 FEES

- A. Secure and pay for necessary permits and fees. Arrange for required inspections.

PART 2 PRODUCTS

2.1 MATERIALS AND METHODS

- A. Equipment and materials shall be new and free from defects. Material and equipment of the same or a similar type shall match that of the manufacturer and model number predominantly existing on the project. Standard production materials shall be used wherever possible.
- B. Work under this division shall be conducted in a manner to cooperate with other trades and contracts involved with this project.

- C. Verify connection requirements for equipment specified or shown and provide materials and labor required to connect the equipment.
- D. Provide painting of electrical items as required by the Architect.
- E. Provide painting in accordance with Division 9 of these specifications.

2.2 INSTALLATION REQUIREMENTS

- A. Electrical plans are diagrammatic. Verify exact equipment locations for equipment. Coordinate with architectural drawings and installations to avoid conflicts. Equipment size and location of equipment is shown wherever possible. Make use of the data in the contract documents and verify this information against actual field conditions. As applicable to the work to be performed, the materials and installation shall conform to the available space, avoid obstruction, preserve headroom, maintain required accessibility, and satisfy the requirements of the governing codes and the standards of good practice. Coordinate with other divisions' drawings and installation to avoid conflicts.
- B. Work shall be installed in a neat, inconspicuous, professional manner. Conduit runs shall parallel structural lines where exposed. Conduit shall run parallel to structural lines whenever possible and specifically when exposed. Whenever possible conduits shall be either concealed in the room ceiling, walls, floor, or exposed ceiling areas tight under the top chord of the ceiling bar joist, or running parallel to the roof wide flange beams, mounted tight to the vertical webs. No conduit shall be run perpendicular to the ceiling roof beams under the bottom chords. No exposed conduit is allowed without prior approval of the Architect. Flexible conduit is allowed only with prior approval of the Architect or Engineer of record.
- C. Existing raceways which are empty may be used whenever possible.
- D. The site shall be left clean and free of dirt and debris. Panels, fixtures, outlets and equipment shall be left clean and free of foreign materials and dirt.

2.3 COORDINATION

- A. Work under this division shall be conducted in a manner to cooperate with other trades and contracts involved with this project.
- B. Consult drawings and specifications for this project and verify the requirements of equipment by other divisions, the Owner, or by other contracts prior to installation and connection.
- C. Consult drawings of other divisions to avoid conflicts with cabinets, counters, equipment, structural members, etc. Resolve any conflicts with the Architect prior to rough-in.

PART 3 EXECUTION

3.1 WARRANTY

- A. Warranty shall be provided for the electrical installation against defects in materials, equipment, and workmanship for one year after the date of acceptance of the work. Defects shall be properly remedied to the satisfaction of the Architect at no cost to the Owner.

END OF SECTION

ELECTRICAL DEMOLITION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical demolition.

1.2 RELATED REQUIREMENTS

- A. Section 017000 - Execution and Closeout Requirements: Additional requirements for alterations work.
- B. Section 260001 - Basic Electrical Materials and Methods.

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify field measurements and circuiting arrangements are as indicated.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Information given on drawings in reference to existing features has been obtained from recent field observation and existing record documents, but cannot be guaranteed to be completely accurate in all respects. Verify all information before proceeding with any work.
- D. Demolition drawings are based on casual field observation and existing record documents.
- E. Report discrepancies to Architect before disturbing existing installation.
- F. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with utility company.

- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Existing Electrical Service: Maintain portions of the existing system as identified on the drawings. Disable system components indicated on the drawings for demolition and to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 7 days before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.
- E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Notify Owner before partially or completely disabling system.
 - 2. Notify local fire service.
 - 3. Make notifications at least 5 days in advance.
 - 4. Make temporary connections to maintain service in areas adjacent to work area.
- F. Existing Telephone and Data Network System: Coordinate demolition of existing data network equipment and cabling with Owner to avoid demolition of items that may need to remain in place or be relocated.
 - 1. Notify Owner at least 5 days before partially or completely disabling system.
 - 2. Notify telephone utility company at least 7 hours before partially or completely disabling system.
 - 3. Make temporary connections to maintain service in areas adjacent to work area.
- G. The Contractor shall carefully review the Architect's project construction plan and schedule and coordinate work within those limitations.
- H. The Contractor shall visit the site and become thoroughly familiar with the existing conditions prior to bidding. Electrical outlets, devices and equipment shown dashed on the demo plans represent existing devices to be demolished. Existing electrical outlets, devices and equipment to remain are shown with "(E)" designation or otherwise specifically noted.
- I. Coordinate work of Division 26 with that of other divisions prior to rough-in.
- J. Existing electrical systems, including, but not limited to, light fixtures, conduit, and wiring which are not to be demolished shall be protected from damage during the demolition and construction phases. Systems shall be operational in a manner consistent with the phasing plan and construction schedule.
- K. Unless otherwise noted, remove existing fixtures, clocks, horns, switches, receptacles, and other wiring devices from surfaces scheduled for refinishing and reinstall new device.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove abandoned wiring to source of supply.

- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- E. Disconnect and remove abandoned panelboards and distribution equipment.
- F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- G. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- H. Repair adjacent construction and finishes damaged during demolition and extension work.
- I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.
- K. Labor and materials required to change the existing electrical installation as indicated shall be provided. Drawings are diagrammatic and do not show existing interconnecting components.
- L. If abandoned or demolished outlets, switches, or other devices serve as feed through boxes for other existing electrical equipment, which is being retained, new conduit and wire shall be provided to bypass the abandoned outlets at no additional cost to the Owner. If existing conduits pass through partitions, which are being removed or remodeled, new conduit and wire shall be provided to route around the wall and maintain service to the existing load at no additional cost to the Owner.
- M. The Contractor shall have the option to reuse existing raceways as far as practical, provided it remains code accessible, concealed by new work, and not in conflict with demolition. New conductors installed in existing raceways shall be THHN/THWN. No existing cloth covered conductors or cables shall be reused. Where existing raceways are used, provide supplemental ground conductor to assure continuity of raceway system. Patch and paint walls where surface conduits were removed. Provide stainless steel cover plates on abandoned J-boxes.
- N. All abandoned Class 2, Class 3, and PLTC cables shall be removed in accordance with Article 725 of NEC.

3.4 CLEANING AND REPAIR

- A. See Section 017419 - Construction Waste Management and Disposal for additional requirements.
- B. Clean and repair existing materials and equipment that remain or that are to be reused.

- C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- D. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.
- E. Owner shall have first right of salvage of any electrical materials and equipment intended for demolition. Items not salvaged by the Owner shall become the property of the Contractor and shall be removed from the site.

END OF SECTION

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Single conductor building wire.
- B. Metal-clad cable.
- C. Wiring connectors.
- D. Oxide inhibiting compound.
- E. Wire pulling lubricant.
- F. Cable ties.

1.2 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 26 00 01 - Basic Electrical Materials and Methods.
- C. Section 260501 - Electrical Demolition: Disconnection, removal, and/or extension of existing electrical conductors and cables.
- D. Section 260526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- E. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 284600 - Fire Detection and Alarm: Fire alarm system conductors and cables.

1.3 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2024).
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2023.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010, with Editorial Revision (2020).
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2020).
- E. FS A-A-59544 - Cable and Wire, Electrical (Power, Fixed Installation); 2008a (Validated 2019).

- F. NEC 210.4(B) - Multiwire Branch Circuits - Disconnection Means; National Electrical Code; 2008.
- G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- H. NECA 120 - Standard for Installing Armored Cable (AC) and Type Metal-Clad (MC) Cable; 2018.
- I. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2021.
- J. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.
- K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- L. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- M. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- N. UL 267 - Outline of Investigation for Wire-Pulling Compounds; Current Edition, Including All Revisions.
- O. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- P. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
- Q. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.
- R. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- C. Field Quality Control Test Reports.

- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.8 FIELD CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.1 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Metal-clad cable is permitted only as follows:
 - 1. Where not otherwise restricted, may be used:
 - a. For branch circuit wiring within a room or space when branch circuits originate from a conduit and wire system in that room or space.
 - b. Where concealed in hollow stud walls, above accessible ceilings and non-accessible ceilings, and under raised floors for branch circuits up to 20 A.
 - 2. In addition to other applicable restrictions, may not be used:
 - a. Where not approved for use by the authority having jurisdiction.
 - b. Where exposed to view, except in dedicated electrical, communications, and mechanical rooms where not subject to damage.
 - c. Where exposed to damage.

- d. In walls with insulation.
 - e. For damp, wet, or corrosive locations, unless provided with a PVC jacket listed as suitable for those locations.
 - f. For isolated ground circuits, unless provided with an additional isolated/insulated grounding conductor.
3. For patient care areas of health care facilities requiring redundant grounding. Unless hospital grade rated and provided with a redundant ground path.

2.2 CONDUCTOR AND CABLE MANUFACTURERS

- A. Cerro Wire LLC: www.cerrowire.com.
- B. Encore Wire Corporation: www.encorewire.com.
- C. American Insulated Wire: www.leviton.com.
- D. Southwire Company: www.southwire.com.
- E. General Cable: www.generalcable.com.
- F. Substitutions: See Section 01 60 00 - Product Requirements.

2.3 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Provide new conductors and cables manufactured not more than one year prior to installation.
- D. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- E. Comply with NEMA WC 70.
- F. Comply with FS A-A-59544 where applicable.
- G. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- H. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- I. Conductors for Grounding and Bonding: Also comply with Section 260526.
- J. Conductors and Cables Installed in Cable Tray: Listed and labeled as suitable for cable tray use.
- K. Conductors and Cables Installed Where Exposed to Direct Rays of Sun: Listed and labeled as sunlight resistant.

- L. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.
- M. Conductor Material:
 - 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
 - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
 - 3. Tinned Copper Conductors: Comply with ASTM B33.
- N. Minimum Conductor Size:
 - 1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
 - 2. Control Circuits: 14 AWG.
- O. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- P. Conductor Color Coding:
 - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 - 2. Color Coding Method: Integrally colored insulation.
 - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
 - 3. Color Code:
 - a. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - b. Equipment Ground, All Systems: Green.
 - c. For control circuits, comply with manufacturer's recommended color code.

2.4 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:
 - 1. Copper Building Wire:
 - a. Cerro Wire LLC: www.cerrowire.com/#sle.
 - b. Encore Wire Corporation: www.encorewire.com/#sle.
 - c. Southwire Company: www.southwire.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- B. Description: Single conductor insulated wire.
- C. Conductor Stranding:
 - 1. Feeders and Branch Circuits:

- a. Size 10 AWG and Smaller: Solid or stranded.
 - b. Size 8 AWG and Larger: Stranded.
- 2. Control Circuits: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
 - a. Size 4 AWG and Larger: Type XHHW-2, THHN/THWN, or THHN/THWN-2.
 - b. Installed Underground: Type XHHW-2, THHN/THWN, or THHN/THWN-2.

2.5 METAL-CLAD CABLE

- A. Manufacturers:
 - 1. AFC Cable Systems Inc: www.afcweb.com/#sle.
 - 2. Encore Wire Corporation: www.encorewire.com/#sle.
 - 3. Southwire Company: www.southwire.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
- C. Conductor Stranding:
 - 1. Size 10 AWG and Smaller: Solid or stranded.
 - 2. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation: Type THHN/THWN or THHN/THWN-2.
- F. Provide dedicated neutral conductor for each phase conductor where indicated or required.
- G. Grounding: Full-size integral equipment grounding conductor.
- H. Armor: Steel, interlocked tape.
- I. Provide PVC jacket applied over cable armor where indicated or required for environment of installed location.

2.6 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 260526.
- C. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors or compression connectors.

2. Copper Conductors Size 6 AWG and Larger: Use compression connectors.
- D. Wiring Connectors for Terminations:
1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 2. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
 3. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
 4. Copper Conductors Size 8 AWG and Larger: Use compression connectors for all connections.
 5. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
 6. Conductors for Control Circuits: Use crimped terminals where connectors are required.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
- G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - c. NSI Industries LLC: www.nsiindustries.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- H. Mechanical Connectors: Provide bolted type or set-screw type.
1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Ilsco: www.ilsco.com/#sle.
 - c. ABB Installation Products: <https://electrification.us.abb.com>.
 - d. Substitutions: See Section 016000 - Product Requirements.
- I. Compression Connectors: Provide circumferential type or hex type crimp configuration.
1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Ilsco: www.ilsco.com/#sle.
 - c. ABB Installation Products: <https://electrification.us.abb.com>.
 - d. Substitutions: See Section 016000 - Product Requirements.
- J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Ilsco: www.ilsco.com/#sle.
 - c. ABB Installation Products: <https://electrification.us.abb.com>.

- d. Substitutions: See Section 016000 - Product Requirements.

2.7 ACCESSORIES

- A. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
 - 1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - c. IlSCO: www.ilSCO.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- B. Wire Pulling Lubricant:
 - 1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. American Polywater Corporation: www.polywater.com/#sle.
 - c. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 - 2. Listed and labeled as complying with UL 267.
 - 3. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
 - 4. Suitable for use at installation temperature.
- C. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.3 INSTALLATION

- A. Circuiting Requirements:
 - 1. Unless dimensioned, circuit routing indicated is diagrammatic.
 - 2. When circuit destination is indicated without specific routing, determine exact routing required.

3. Arrange circuiting to minimize splices.
 4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
 5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits that originate in the same panelboard are shown as separate, combining them together in a single raceway is permitted, under the following conditions:
 - a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
 - b. Increase size of conductors as required to account for ampacity derating.
 - c. Size raceways, boxes, etc. to accommodate conductors.
 8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
- B. Install products in accordance with manufacturer's instructions.
- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Install metal-clad cable (Type MC) in accordance with NECA 120.
- E. Installation in Raceway:
1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 2. Pull all conductors and cables together into raceway at same time.
 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- F. Exposed Cable Installation (only where specifically permitted):
1. Route cables parallel or perpendicular to building structural members and surfaces.
 2. Protect cables from physical damage.
- G. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- H. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
 2. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.
- I. Terminate cables using suitable fittings.

1. Metal-Clad Cable (Type MC):
 - a. Use listed fittings.
 - b. Use steel or malleable iron. Do not use die-cast zinc.
 - c. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
 - d. Do not use direct-bearing set-screw type fittings for cables with aluminum armor.
- J. Install conductors with a minimum of 6 inches of slack at each outlet.
- K. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.
- L. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- M. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- N. Make wiring connections using specified wiring connectors.
 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies.
 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 3. Do not remove conductor strands to facilitate insertion into connector.
 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminants. Do not use wire brush on plated connector surfaces.
 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- O. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
 1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
 - b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.
 2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
 3. Wet Locations: Use heat shrink tubing.

- P. Insulate ends of spare conductors using vinyl insulating electrical tape.
- Q. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- R. Identify conductors and cables in accordance with Section 260553.
- S. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- T. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.
- U. Install wire and cable securely, in a neat and workmanlike manner, as specified in NECA 1. Contractor shall comply with NEC 210.4(B) by providing a separate neutral conductor for each circuit in a multi-wire branch circuit.
- V. Support cables above accessible ceiling, using spring metal clips or plastic cable ties to support cables from structure or ceiling suspension system. Do not rest cable on ceiling panels. Do not attach cables to slack wires. Plastic cable ties shall be plenum rated in plenum spaces.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is only required for services and feeders.
 - 1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
- D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.
- E. Ground rod electrodes.

1.2 RELATED REQUIREMENTS

- A. Section 26 00 01 - Basic Electrical Materials and Methods.
- B. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
 - 1. Includes oxide inhibiting compound.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 265100 - Lighting.

1.3 REFERENCE STANDARDS

- A. BICSI TDMM - Telecommunications Distribution Methods Manual, 15th Edition; 2024.
- B. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2025.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- D. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2022.
- E. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. TIA-607 - Commercial Building Grounding and Bonding Requirements for Telecommunications; 2013.
- H. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify exact locations of underground metal water service pipe entrances to building.
 - 2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Field quality control test reports.
- E. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.

- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- E. Grounding System Resistance:
 - 1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
 - 2. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.
- F. Grounding Electrode System:
 - 1. Verify connection to existing required and supplemental grounding electrodes to form grounding electrode system.
 - a. Existing ground electrode system shall have continuous grounding electrode conductors without splice or joint.
 - b. Report any discrepancies to the engineer of record.
 - 2. Metal Underground Water Pipe(s):
 - a. Existing ground electrode system shall have connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
 - b. Report any discrepancies to the engineer of record.
 - 3. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
- G. Service-Supplied System Grounding:
 - 1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
 - 2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.
 - 3. For existing systems, verify existing grounding electrode system and report any discrepancies to the engineer of record.
- H. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:
 - 1. Provide equipment grounding conductor routed with supply conductors.
 - 2. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
 - 3. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.
 - 4. For existing systems, verify existing grounding electrode system and report any discrepancies to the engineer of record.
- I. Separately Derived System Grounding:

1. Separately derived systems include, but are not limited to:
 - a. Transformers (except autotransformers such as buck-boost transformers).
 2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame, nearest effectively grounded metal water pipe, or common grounding electrode conductor ground riser. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure or neutral (grounded) bus in first disconnecting means.
 3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
 4. Where common grounding electrode conductor ground riser is used for tap connections to multiple separately derived systems, provide bonding jumper to connect the metal building frame and metal water piping in the area served by the derived system to the common grounding electrode conductor.
 5. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.
 6. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
 7. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.
- J. Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
 2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
 3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
 4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
 5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
 6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
 7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
 - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
 - b. Metal gas piping.
 - c. Metal process piping.
 8. Provide bonding for interior metal air ducts.
 9. Provide bonding for metal building frame.

10. Provide bonding for metal siding not effectively bonded through attachment to metal building frame.
 11. Provide bonding and equipment grounding for pools and fountains and associated equipment in accordance with NFPA 70.
 12. Provide redundant grounding and bonding for patient care areas of health care facilities in accordance with NFPA 70 and NFPA 99.
- K. Communications Systems Grounding and Bonding:
1. Verify existing intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70. Report any discrepancies to the engineer of record.
 2. Verify existing bonding jumper from intersystem bonding termination or building grounding electrode system to each communications room or backboard and provide ground bar for termination. Report any discrepancies to the engineer of record.
 - a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
 - b. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
 - c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
 3. Telecommunications Grounding System:
 - a. Install in accordance with BICSI TDM, TIA/EIA 607, and NFPA 70.
 - b. Install grounding and bonding conductors concealed from view as much as possible.
 - c. Install grounding for each rack and equipment using #6 AWG THHN, rated for 90 degrees C, insulated, copper stranded conductor to copper communication grounding bus bar.
 - d. Install routing for grounding conductor as short and direct as practical.
 - e. Install routing of bonding conductors with minimum number of bends and no splices. Use sweeping bends.
 - f. Install bonding connections with listed bolts, clamps, or lugs. Exothermic welding may be used.
 - g. Between each communications room, install multiple busbars directly bonded with #6 AWG copper conductor.
 - h. Ground data cabinets, racks, cable trays, and mounting hardware located in all telecommunications rooms.
 - i. Install ground from each piece of equipment to grounding bar via an insulated cable no smaller than #6 AWG stranded copper wire. Install proper grounding lug on cable where connecting to racks and grounding bar.
 - j. Label grounding conductors and grounding bus bars in accordance with BICSI guidelines.

2.2 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 260526:
1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:

- 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
 - a. Exceptions:
 - 1) Use mechanical connectors for connections to electrodes at ground access wells.
 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
 - a. Exceptions:
 - 1) Use exothermic welded connections for connections to metal building frame.
 4. Manufacturers - Mechanical and Compression Connectors:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Harger Lightning & Grounding: www.harger.com/#sle.
 - c. ABB Installation Products: <https://electrification.us.abb.com>.
 - d. Substitutions: See Section 016000 - Product Requirements.
 5. Manufacturers - Exothermic Welded Connections:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Cadweld, a brand of Erico International Corporation: www.erico.com/#sle.
 - c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- D. Ground Bars:
1. Description: Copper rectangular ground bars with mounting brackets and insulators.
 2. Size: As specified herein.
 3. Holes for Connections: As indicated or as required for connections to be made.
 4. Manufacturers:
 - a. Erico International Corporation: www.erico.com/#sle.
 - b. Harger Lightning & Grounding: www.harger.com/#sle.
 - c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- E. Ground Rod Electrodes:
1. Comply with NEMA GR 1.
 2. Material: Copper-bonded (copper-clad) steel.
 3. Size: 5/8 inch diameter by 10 feet length, unless otherwise indicated.
 4. Where rod lengths of greater than 10 feet are indicated or otherwise required, sectionalized ground rods may be used.
 5. Manufacturers:
 - a. Erico International Corporation: www.erico.com/#sle.
 - b. Galvan Industries, Inc: www.galvanelectrical.com/#sle.

- c. Harger Lightning & Grounding: www.harger.com/#sle.
- d. Substitutions: See Section 016000 - Product Requirements.

F. Oxide Inhibiting Compound: Comply with Section 260519.

PART 3 EXECUTION

3.1 PREPARATION

- A. Remove paint, rust, mill oils, and surface contaminants at connection points.

3.2 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as indicated.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.3 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
 - 1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
 - 2. Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.
- D. Make grounding and bonding connections using specified connectors.
 - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 - 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 - 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
- E. Identify grounding and bonding system components in accordance with Section 260553.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.

- B. Perform inspection, testing, and adjusting in accordance with Section 014000.
- C. Inspect and test in accordance with NETA ATS except Section 4.
- D. Perform inspections and tests listed in NETA ATS, Section 7.13.
- E. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- F. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.
- G. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 055000 - Metal Fabrications: Materials and requirements for fabricated metal supports.
- C. Section 260001 - Basic Electrical Materials and Methods.
- D. Section 260534 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
- E. Section 260537 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.
- F. Section 265100 - Lighting: Additional support and attachment requirements for interior luminaires.

1.3 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.
- D. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2018, with Editorial Revision (2020).
- E. ICC-ES AC106 - Acceptance Criteria for Pre drilled Fasteners (Screw Anchors) in Masonry; 2018, with Editorial Revision (2020).
- F. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2017, with Editorial Revision (2020).
- G. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2023.

- H. MFMA-4 - Metal Framing Standards Publication; 2004.
- I. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- K. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
 - 2. Coordinate work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.
 - 4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has cured; see Section 033000.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel/strut framing systems, nonpenetrating rooftop supports, and post-installed concrete/masonry anchors.
- C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
- D. Evaluation Reports: For products specified as requiring evaluation and recognition by ICC Evaluation Service, LLC (ICC-ES), provide current ICC-ES evaluation reports upon request.
- E. Product Data: Provide manufacturer's catalog data for fastening systems.
- F. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

- A. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

- B. Maintain at project site one copy of each referenced document that prescribes execution requirements.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Comply with the following. Where requirements differ, comply with most stringent.
 - a. NFPA 70.
 - b. Applicable building code.
 - c. Requirements of authorities having jurisdiction.
 - 2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical work.
 - 3. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or Intertek (ETL) as suitable for purpose intended, where applicable.
 - 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported with minimum safety factor of 5. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 - 6. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 - 7. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel or stainless steel unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Materials for Metal Fabricated Supports: See Section 055000.
- C. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
 - 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 - 2. Conduit Clamps: Bolted type unless otherwise indicated.
 - 3. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Erico International Corporation: www.erico.com/#sle.
 - c. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - d. ABB Installation Products: <https://electrification.us.abb.com>.
 - e. Substitutions: See Section 016000 - Product Requirements.
- D. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.
 - 1. Manufacturers:

- a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Erico International Corporation: www.erico.com/#sle.
 - c. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - d. ABB Installation Products: <https://electrification.us.abb.com>.
 - e. Substitutions: See Section 016000 - Product Requirements.

- E. Metal Channel/Strut Framing Systems:
 - 1. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation[<>]: www.cooperindustries.com/#sle.
 - b. ABB Installation Products: <https://electrification.us.abb.com>.
 - c. Unistrut, Atkore International Inc; Unistrut: www.unistrut.us/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 - 2. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
 - 3. Comply with MFMA-4.
 - 4. Channel/Strut Used as Raceway, Where Indicated: Listed and labeled as complying with UL 5B.
 - 5. Channel Material:
 - a. Indoor Dry Locations: Use zinc-plated steel or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel or stainless steel.
 - 6. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
 - 7. Minimum Channel Dimensions: 1-5/8 inch wide by 13/16 inch high.

- F. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
 - 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2-inch diameter.
 - b. Single Conduit up to 1-inch (27 mm) Trade Size: 1/4-inch diameter.
 - c. Single Conduit Larger than 1-inch (27 mm) Trade Size: 3/8-inch diameter.
 - d. Trapeze Support for Multiple Conduits: 3/8-inch diameter.
 - e. Outlet Boxes: 1/4-inch diameter.
 - f. Luminaires: 1/4-inch diameter.

- G. Nonpenetrating Rooftop Supports for Low-Slope Roofs:
 - 1. Manufacturers:
 - a. Cooper B-Line, a division of Cooper Industries: www.cooperindustries.com.
 - b. Atkore International Inc; Unistrut: www.unistrut.us/#sle.
 - c. PHP Systems/Design: www.phpsd.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 - 2. Description: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring attachment to roof structure and not penetrating roofing assembly, with support fixtures as specified.
 - 3. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - 4. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
 - 5. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.

6. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.

H. Anchors and Fasteners:

1. Manufacturers - Mechanical Anchors:
 - a. Hilti, Inc: www.hilti.com/#sle.
 - b. Power Fasteners, Inc: www.powers.com.
 - c. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
2. Manufacturers - Powder-Actuated Fastening Systems:
 - a. Hilti, Inc: www.hilti.com/#sle.
 - b. Power Fasteners, Inc: www.powers.com.
 - c. ITW Ramset, a division of Illinois Tool Works, Inc: www.ramset.com/#sle.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
3. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.
4. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
5. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
6. Hollow Masonry: Use toggle bolts.
7. Hollow Stud Walls: Use toggle bolts.
8. Steel: Use beam clamps, machine bolts, or welded threaded studs.
9. Sheet Metal: Use sheet metal screws.
10. Wood: Use wood screws.
11. Plastic and lead anchors are not permitted.
12. Powder-actuated fasteners are permitted only as follows:
 - a. Where approved by Architect.
 - b. Use only threaded studs; do not use pins.
13. Hammer-driven anchors and fasteners are permitted only as follows:
 - a. Nails are permitted for attachment of nonmetallic boxes to wood frame construction (when specified).
 - b. Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction (when specified).
14. Preset Concrete Inserts: Continuous metal channel/strut and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Manufacturer: Same as manufacturer of metal channel/strut framing system.
 - b. Comply with MFMA-4.
 - c. Channel Material: Use galvanized steel.
 - d. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.
15. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

2.2 MATERIALS

- A. Hangers, Supports, Anchors, and Fasteners - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.

- B. Supports: Fabricated of structural steel or framed steel members; galvanized.
- C. Anchors and Fasteners:
 - 1. Obtain permission from Architect before using powder-actuated anchors.
 - 2. Concrete Structural Elements: Use precast inserts, expansion anchors, or preset inserts.
 - 3. Steel Structural Elements: Use beam clamps, steel spring clips, steel ramset fasteners, or welded fasteners.
 - 4. Concrete Surfaces: Use self-drilling anchors or expansion anchors.
 - 5. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts or hollow wall fasteners.
 - 6. Solid Masonry Walls: Use expansion anchors or preset inserts.
 - 7. Sheet Metal: Use sheet metal screws.
 - 8. Wood Elements: Use wood screws.
- D. Fastener Types:
 - 1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 - 2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
 - 3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
 - 4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
- E. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
 - 1. Other Types: As required.
 - 2. Manufacturers:
 - a. Powers Fasteners, Inc.: www.powers.com.
 - b. Substitutions: See Section 016000 - Product Requirements.
 - c. Substitutions:
 - 3. Formed Steel Channel:
 - a. Manufacturer: Kindorf, Unistrut, B-Line, or approved.
 - b. Substitutions: See Section 016000 - Product Requirements.
 - 4. Steel Spring Clips:
 - a. Manufacturer: Caddy, Raco, T&B, B-Line.
 - b. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install hangers and supports as required to adequately and securely support electrical system components, in a neat and workmanlike manner, as specified in NECA 1.
 - 1. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

2. Obtain permission from Architect before drilling or cutting structural members.
- C. Rigidly weld support members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- D. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- E. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1 inch off wall.
- F. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- G. Perform work in accordance with NECA 1 (general workmanship).
- H. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- I. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- J. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- K. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- L. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- M. Field Welding, Where Approved by Architect: See Section 055000.
- N. Equipment Support and Attachment:
 1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
 2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 4. Unless otherwise indicated, mount floor-mounted equipment on properly sized concrete pad 3 inches in height; see Section 033000.
 5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- O. Conduit Support and Attachment: See Section 260534 for additional requirements.
- P. Box Support and Attachment: See Section 260537 for additional requirements.
- Q. Interior Luminaire Support and Attachment: See Section 265100 for additional requirements.
- R. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

Hangers and Supports for Electrical Systems

- S. Secure fasteners in accordance with manufacturer's recommended torque settings.
- T. Remove temporary supports.
- U. Identify independent electrical component support wires above accessible ceilings, where permitted, with color distinguishable from ceiling support wires in accordance with NFPA 70.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Aluminum rigid metal conduit (RMC).
- C. Galvanized steel intermediate metal conduit (IMC).
- D. PVC-coated galvanized steel rigid metal conduit (RMC).
- E. Flexible metal conduit (FMC).
- F. Liquidtight flexible metal conduit (LFMC).
- G. Galvanized steel electrical metallic tubing (EMT).
- H. Rigid polyvinyl chloride (PVC) conduit.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete encasement of conduits.
- B. Section 078400 - Firestopping.
- C. Section 260001 - Basic Electrical Materials and Methods.
- D. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Cable assemblies consisting of conductors protected by integral metal armor.
- E. Section 260526 - Grounding and Bonding for Electrical Systems.
 - 1. Includes additional requirements for fittings for grounding and bonding.
- F. Section 260529 - Hangers and Supports for Electrical Systems.
- G. Section 260537 - Boxes for Electrical Systems.
- H. Section 260535 - Identification for Electrical Systems.
- I. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- J. Section 270528 - Pathways for Low Voltage Systems Cabling: Additional requirements for communications systems conduits.
- K. Section 312316 - Excavation.
- L. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

- M. Section 312323 - Fill: Bedding and backfilling.

1.3 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2025.
- B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2020.
- C. ANSI C80.5 - American National Standard for Electrical Rigid Metal Conduit - Aluminum (ERMC-A); 2025.
- D. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit; 2025.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- F. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2020.
- G. NECA 102 - Standard for Installing Aluminum Rigid Metal Conduit; 2004.
- H. NECA 111 - - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC, PVC); 2025.
- I. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
- J. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit; 2018.
- K. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2020.
- L. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2021.
- M. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- N. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
- O. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- P. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.
- Q. UL 360 - Liquid-Tight Flexible Metal Conduit; Current Edition, Including All Revisions.
- R. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.
- S. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- T. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

- U. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- V. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.
- W. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.
- X. UL 2419 - Outline of Investigation for Electrically Conductive Corrosion Resistant Compounds; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts installed under other sections or by other.
 - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed in other sections or by others.
 - 4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.
 - 5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.
 - 2. For projects with Post Tension (PT) slab construction, submit dimensioned plan showing all conduit sleeves & block out locations to Architect for review.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- C. Shop Drawings:
 - 1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.
 - 2. Include proposed locations of roof penetrations and proposed methods for sealing.
- D. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2-inch (53 mm) trade size and larger.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

- B. Documents at Project Site: Maintain at project site one copy of manufacturer's instructions, shop drawings, and reference standard documents containing execution requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.
- C. Underground:
 - 1. Under Slab on Grade: Use galvanized steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), or rigid PVC conduit.
 - 2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
 - 3. Where rigid polyvinyl chloride (PVC) conduit is provided, transition to galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC) where emerging from underground.
 - 4. Where rigid polyvinyl (PVC) conduit larger than 2-inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit (RMC) elbows, galvanized steel intermediate metal conduit (IMC) elbows, or fiberglass for bends in runs over 100 feet. For shorter runs, factory formed Schedule 40 PVC may be used.
 - 5. 1.5 Inches Diameter and Smaller: For total conduit lengths between pull points over 100 ft., use rigid steel elbows. For shorter overall lengths, rigid steel or Schedule 40 PVC may be used.
 - 6. Where galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC) is installed in direct contact with earth where soil has resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape, factory-applied corrosion protection coating, or field-applied corrosion protection compound acceptable to authorities having jurisdiction to provide supplementary corrosion protection.
- D. Embedded Within Concrete:
 - 1. Within Slab on Grade (within structural slabs only where approved by Structural Engineer): Use galvanized steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), or rigid PVC conduit.

2. Within Slab Above Ground (within structural slabs only where approved by Structural Engineer): Use galvanized steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), or rigid PVC conduit.
 3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), or rigid PVC conduit.
 4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit (RMC) where emerging from concrete.
- E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or galvanized steel electrical metallic tubing (EMT).
- F. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or galvanized steel electrical metallic tubing (EMT).
- G. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).
- H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit (RMC).
- I. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or galvanized steel electrical metallic tubing (EMT).
- J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC).
1. Locations subject to physical damage include, but are not limited to:
 - a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
 - b. Where exposed below 20 feet in warehouse and manufacturing areas.
- K. Exposed, Exterior: Use galvanized steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or PVC-coated galvanized steel rigid metal conduit (RMC).
- L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC).
- M. Corrosive Locations Above Ground: Use aluminum rigid metal conduit (RMC) or PVC-coated galvanized steel rigid metal conduit (RMC).
1. Corrosive locations include, but are not limited to:
 - a. Cooling towers.
 - b. Swimming pools and associated equipment areas.
- N. Hazardous/Classified Locations: Use galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC).

- O. Flexible Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit (FMC).
 - 1. Maximum Length: 6 feet.
- P. Flexible Connections to Vibrating Equipment:
 - 1. Dry Locations: Use flexible metal conduit (FMC).
 - 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit (LFMC).
 - 3. Maximum Length: 6 feet unless otherwise indicated.
 - 4. Vibrating equipment includes, but is not limited to:
 - a. Transformers.
 - b. Motors.
- Q. Fished in Existing Walls, Where Necessary: Use flexible metal conduit (FMC) or MC cable.

2.2 CONDUIT - GENERAL REQUIREMENTS

- A. Comply with NFPA 70.
- B. Electrical Service Conduits.
- C. Communications Systems Conduits: Also comply with Section 271000 or 27 13 43.
- D. Fittings for Grounding and Bonding: See Section 260526 for additional requirements.
- E. Provide conduit, fittings, supports, and accessories required for complete raceway system.
- F. Provide products listed, classified, and labeled as suitable for purpose intended.
- G. Minimum Conduit Size, Unless Otherwise Indicated:
 - 1. Branch Circuits: 1/2-inch trade size.
 - 2. Branch Circuit Homeruns: 3/4-inch trade size.
 - 3. Control Circuits: 1/2-inch trade size.
 - 4. Flexible Connections to Luminaires: 1/2-inch trade size.
 - 5. Underground, Interior: 3/4-inch trade size.
 - 6. Underground, Exterior: 3/4-inch trade size.
- H. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 - 2. Republic Conduit: www.republic-conduit.com.
 - 3. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- C. Fittings:
 - 1. Manufacturers:

- a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - b. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - c. ABB Installation Products: <https://electrification.us.abb.com>.
- 2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
- 3. Hazardous/Classified Locations: Use fittings listed and labeled as complying with UL 1203 for classification of installed location.
- 4. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.
- 5. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.4 ALUMINUM RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 - 2. Nucor Tubular Products: www.nucortubular.com/#sle.
 - 3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
 - 4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
- B. Description: NFPA 70, Type RMC aluminum rigid metal conduit complying with ANSI C80.5 and listed and labeled as complying with UL 6A.
- C. Fittings:
 - 1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
 - c. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - 2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6A
 - 3. Material: Use aluminum.
 - 4. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.5 GALVANIZED STEEL INTERMEDIATE METAL CONDUIT (IMC)

- A. Manufacturers:
 - 1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 - 2. Republic Conduit: www.republic-conduit.com.
 - 3. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
- B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.
- C. Fittings:
 - 1. Manufacturers:
 - a. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - b. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - c. ABB Installation Products: <https://electrification.us.abb.com>.

2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
3. Hazardous/Classified Locations: Use fittings listed and labeled as complying with UL 1203 for classification of installed location.
4. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.
5. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.6 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 1. ABB; Ocal: www.electrification.us.abb.com/#sle.
 2. Calbond, a division of Atkore International www.calbond.com/#sle
 3. Robroy Industries: www.robroy.com/#sle.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
- C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil, 0.040 inch.
- D. PVC-Coated Boxes and Fittings:
 1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
 2. Nonhazardous Locations: Use boxes and fittings listed and labeled as complying with UL 514A, UL 514B, or UL 6.
 3. Hazardous/Classified Locations: Use fittings listed and labeled as complying with UL 1203 for classification of installed location.
 4. Material: Use steel or malleable iron.
 5. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil, 0.040 inch.
- E. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil, 0.015 inch.

2.7 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers:
 1. AFC Cable Systems, a division of Atkore International: www.afcweb.com/#sle.
 2. Electri-Flex Company: www.electriflex.com/#sle.
 3. International Metal Hose: www.metalhose.com/#sle.
- B. Description: NFPA 70, Type FMC standard-wall steel or standard-wall aluminum flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.
- C. Fittings:
 1. Manufacturers:
 - a. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - b. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - c. ABB Installation Products: <https://electrification.us.abb.com>.

2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel, malleable iron, or aluminum.
 - a. Do not use die cast zinc fittings.

2.8 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
 1. AFC Cable Systems, a division of Atkore International: www.afcweb.com/#sle.
 2. Electri-Flex Company: www.electriflex.com/#sle.
 3. International Metal Hose: www.metalhose.com/#sle.
- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel or aluminum flexible metal conduit listed and labeled as complying with UL 360.
- C. Fittings:
 1. Manufacturers:
 - a. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - b. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - c. ABB Installation Products: <https://electrification.us.abb.com>.
 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use steel, malleable iron, or aluminum.
 - a. Do not use die cast zinc fittings.

2.9 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 2. Republic Conduit: www.republic-conduit.com.
 3. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
- B. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
 1. Manufacturers:
 - a. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - b. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - c. ABB Installation Products: <https://electrification.us.abb.com>.
 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use steel.
 4. Connectors and Couplings: Use set-screw except when embedded in concrete. Use concrete right compression (gland) type in concrete.
 - a. Do not use indenter type connectors and couplings.

2.10 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Manufacturers:
 1. ABB; Carlon: www.carlon.com/#sle.

2. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 3. Cantex Inc: www.cantexinc.com/#sle.
 4. JM Eagle: www.jmeagle.com/#sle.
- B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.
- C. Fittings:
1. Manufacturer: Same as manufacturer of conduit to be connected.
 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.
- D. Elbows:
1. Use only factory formed Schedule 40 elbows. Field bends are not acceptable.
 2. 1.5 Inches Diameter and Smaller: For total conduit lengths between pull points over 100 ft., use rigid steel elbows. For shorter overall lengths, rigid steel or Schedule 40 PVC may be used.
 3. 2 Inches Diameter and Larger: For total conduit lengths between pull points over 100 ft., use long sweep rigid steel or fiberglass elbows. For shorter overall lengths, rigid steel, fiberglass, or Schedule 40 PVC elbows may be used.

2.11 ACCESSORIES

- A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil, 0.020 inch.
- B. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.
- C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- D. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf.
- E. Sealing Compound for Hazardous/Classified Location Sealing Fittings: Listed for use with particular fittings to be installed.
- F. Sealing Systems for Concrete Penetrations:
1. Sleeves: Provide water stop ring or cement coating that bonds to concrete to prevent water infiltration.
 2. Rate for minimum of 40 psig; suitable for sealing around conduits to be installed.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.

- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in accordance with NECA 1.
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install aluminum rigid metal conduit (RMC) in accordance with NECA 102.
- E. Install intermediate metal conduit (IMC) in accordance with NECA 101.
- F. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by manufacturer.
- G. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- H. Conduit Routing:
 - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 - 2. When conduit destination is indicated without specific routing, determine exact routing required.
 - 3. Conceal conduits unless specifically indicated to be exposed.
 - 4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 - c. Within joists in areas with no ceiling.
 - 5. Unless otherwise approved, do not route exposed conduits:
 - a. Across floors.
 - b. Across roofs.
 - c. Across top of parapet walls.
 - d. Across building exterior surfaces.
 - 6. Conduits installed underground or embedded in concrete may be routed in shortest possible manner unless otherwise indicated. Route other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
 - 7. Arrange conduit to maintain adequate headroom, clearances, and access.
 - 8. Arrange conduit to provide no more than equivalent of three 90-degree bends between pull points.
 - 9. Arrange conduit to provide no more than 150 feet between pull points.
 - 10. Route conduits above water and drain piping where possible.
 - 11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
 - 12. Maintain minimum clearance of 12 inches between conduits and hot surfaces.
 - 13. Group parallel conduits in same area on common rack.
- I. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 260529.
 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
 4. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
 5. Use metal channel/strut with accessory conduit clamps to support multiple parallel surface-mounted conduits.
 6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
 7. Use trapeze hangers assembled from threaded rods and metal channel/strut with accessory conduit clamps to support multiple parallel suspended conduits.
 8. Use nonpenetrating rooftop supports to support conduits routed across rooftops, where approved.
 9. Use of spring steel conduit clips for support of conduits is not permitted.
 10. Use of wire for support of conduits is not permitted.
 11. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with most stringent requirements.
- J. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
 3. Use suitable adapters where required to transition from one type of conduit to another.
 4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
 6. Where spare conduits stub up through concrete floors and are not terminated in box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
 7. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
 8. Secure joints and connections to provide mechanical strength and electrical continuity.
- K. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 4. Conceal bends for conduit risers emerging above ground.
 5. Provide suitable sealing system where conduits penetrate exterior wall below grade.
 6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations

- are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
8. Provide metal escutcheon plates for conduit penetrations exposed to public view.
 9. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 078400.
- L. Underground Installation:
1. Provide trenching and backfilling; see Section 312316 and Section 312323.
 2. Minimum Cover, Unless Otherwise Indicated or Required:
 - a. Underground, Exterior: 24 inches.
 - b. Under Slab on Grade: 12 inches to bottom of slab.
 3. Provide underground warning tape along entire conduit length for service entrance where not concrete-encased; see Section 260553.
- M. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
1. Include proposed conduit arrangement with submittals.
 2. Maximum Conduit Size: 1-inch trade size unless otherwise approved.
 3. Minimum Conduit Spacing: Shall be as directed by Structural Engineer.
 4. Install conduits within middle one third of slab thickness.
 5. Secure conduits to prevent floating or movement during pouring of concrete.
- N. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide minimum concrete cover of 3 inches on all sides unless otherwise indicated; see Section 033000.
- O. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
 3. Where conduits are subject to earth movement by settlement or frost.
- P. Conduit Sealing:
1. Use seal fitting or approved sealing compound to prevent entry of moisture and gases. This includes, but is not limited to:
 - a. Where conduits enter building from outside.
 - b. Where service conduits enter building from underground distribution system.
 - c. Where conduits enter building from underground.
 - d. Where conduits may transport moisture to contact live parts.
 2. Where conduits cross barriers between areas of potential substantial temperature differential, use seal fitting or approved sealing compound at accessible point near penetration to prevent condensation. This includes, but is not limited to:
 - a. Where conduits pass from outdoors into conditioned interior spaces.
 - b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
 - c. Where conduits penetrate coolers or freezers.
 3. Where conduits cross boundaries of hazardous/classified locations, provide identified/listed sealing fittings located as indicated or in accordance with NFPA 70.

- Q. Provide pull string in each empty conduit and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- R. Do not cross conduits in slab.
- S. Cut conduit square using saw or pipecutter; de-burr cut ends.
- T. Bring conduit to shoulder of fittings; fasten securely.
- U. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes minimum.
- V. Use suitable caps to protect installed conduit against entrance of dirt and moisture.
- W. All elbows installed in primary and secondary power conduit runs shall be minimum 36-inch radius.
- X. Where conduit is shown stubbed into a telephone, computer or communication terminal area, conduit shall be stubbed up 6 inches below ceiling and terminated with insulating bushings.
- Y. Where the contractor elects to utilize PVC in lieu of GRC, the contractor shall provide supplemental ground bus in terminating switch and panelboards, and green ground wire as per code rules.
- Z. Conduit runs shall not exceed 100 feet without an accessible pull box installed in line.
- AA. Communications system conduit run above the ceiling shall not be installed within 12 inches of a parallel run of current carrying conductors, transformers, feeder cables, motors, fluorescent lighting ballasts or LED lighting driver.
- BB. Conduit connections between outlet boxes less than 24 inches apart on opposite sides of a wall shall be made with a loop of flexible conduit to limit sound transmission.
- CC. Penetrations of Masonry and Concrete Constructions:
 - 1. Ensure that the sound control performance of structures be maintained in accordance with the drawings and specifications. All penetrations shall be installed in a manner that results in complete air tightness through structure. If a condition occurs where penetration of the structure by a conduit is not shown clearly on the drawings (or described in the specifications), the Contractor shall ask immediately for clarification of the method necessary to install the particular item.
- DD. Penetrations of Drywall Constructions:
 - 1. Ensure that the sound control performance of structures be maintained in accordance with the drawings and specifications. All penetrations shall be installed in a manner that results in complete air tightness through structure. If a condition occurs where penetration of the structure by a conduit is not shown clearly on the drawings (or described in the specifications), the Contractor shall ask immediately for clarification of the method necessary to install the particular item.

- EE. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- FF. To attenuate objectionable EMI and RFI signals, the audio and video system raceway groups shall maintain a specified minimum distance separation whenever possible within the constraints of the building's architecture. System conduit groups that run parallel with each other shall adhere to the following table of minimum distance separation:

<u>Audio/Video Sub-System</u>	Microphone	Line	Speaker	Video
Microphone	Adjacent	6 inches	12 inches	12 inches
Line	6 inches	Adjacent	12 inches	6 inches
Speaker	12 inches	6 inches	Adjacent	6 inches
Video	12 inches	6 inches	6 inches	Adjacent

- GG. Audio and video system conduit that runs parallel with AC power conduit shall be separated by at least 3 feet minimum.
- HH. Audio and video system conduit that runs across or perpendicular to AC power conduit shall be separated by at least 1 foot minimum.
- II. To attenuate objectionable EMI and RFI signals, the telecommunications system raceway and cable shall maintain a specified minimum distance separation whenever possible within the constraints of the building's architecture.

<u>Condition</u>	<u>Minimum Separation Distance</u>
Unshielded power lines or electrical equipment in proximity to open or nonmetal telecommunication pathways	24 inches
Unshielded power lines or electrical equipment in proximity to a grounded metal telecommunication conduit pathway	12 inches
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal telecommunication conduit pathway	12 inches
Electrical motors, transformers, generators, frequency converters, and UPS systems	47 inches

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
- C. Correct deficiencies and replace damaged or defective conduits.

3.4 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter.

3.5 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wireways.

1.2 RELATED REQUIREMENTS

- A. Section 260001 - Basic Electrical Materials and Methods.
- B. Section 260526 - Grounding and Bonding for Electrical Systems.
- C. Section 260529 - Hangers and Supports for Electrical Systems.
- D. Section 260534 - Conduit for Electrical Systems.
- E. Section 260537 - Boxes for Electrical Systems.
- F. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 870 - Wireways, Auxiliary Gutters, and Associated Fittings; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of raceways with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Verify minimum sizes of raceways with the actual conductors and components to be installed.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install raceways until final surface finishes and painting are complete.
 - 2. Do not begin installation of conductors and cables until installation of raceways is complete between outlet, junction and splicing points.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets including dimensions, knockout sizes and locations, materials, fabrication details, finishes, service condition requirements, and accessories.
- C. Shop Drawings:
 - 1. Wireways: Provide dimensioned plan and elevation views including adjacent equipment with all required clearances indicated.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 RACEWAY REQUIREMENTS

- A. Provide all components, fittings, supports, and accessories required for a complete raceway system.
- B. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc (UL) or Intertek (ETL) as suitable for the purpose intended.
- C. Do not use raceways for applications other than as permitted by NFPA 70 and product listing.

2.2 WIREWAYS

- A. Manufacturers:
 - 1. Cooper B-Line, a division of Cooper Industries: www.cooperindustries.com/#sle.
 - 2. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com/#sle.
 - 3. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
 - 4. Siemens: www.usa.siemens.com.
 - 5. GE: www.ge.com.

- B. Description: Lay-in wireways and wiring troughs with removable covers; listed and labeled as complying with UL 870.
- C. Wireway Type, Unless Otherwise Indicated:
 - 1. Indoor Clean, Dry Locations: NEMA EN 10250, Type 1, painted steel or Type 12, painted steel with screw cover, hinged cover, or secured with screws.
 - 2. Outdoor Locations: NEMA EN 10250, Type 3R, painted steel with screw cover, hinged cover, or secured with screws.
- D. Finish for Painted Steel Wireways: Manufacturer's standard grey unless otherwise indicated.
- E. Minimum Wireway Size: 4 by 4 inches unless otherwise indicated.
- F. Where wireway size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 SOURCE QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive raceways and that final surface finishes are complete, including painting.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install raceways plumb and level.
- D. Arrange wireways and associated raceway connections to comply with NFPA 70, including but not limited to requirements for deflected conductors and wireways used as pullboxes. Increase size of wireway where necessary.
- E. Secure and support raceways in accordance with Section 260529 at intervals complying with NFPA 70 and manufacturer's requirements.
- F. Close unused raceway openings.
- G. Provide grounding and bonding in accordance with Section 260526.
- H. Identify raceways in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect raceways for damage and defects.
- C. Correct wiring deficiencies and replace damaged or defective raceways.

3.4 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.5 PROTECTION

- A. Protect installed raceways from subsequent construction operations.

END OF SECTION

BOXES FOR ELECTRICAL SYSTEMS**PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete.
- B. Section 078400 - Firestopping.
- C. Section 083100 - Access Doors and Panels: Panels for maintaining access to concealed boxes.
- D. Section 260001 - Basic Electrical Materials and Methods.
- E. Section 260526 - Grounding and Bonding for Electrical Systems.
- F. Section 260529 - Hangers and Supports for Electrical Systems.
- G. Section 260534 - Conduit for Electrical Systems:
 - 1. Conduit bodies and other fittings.
 - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- H. Section 260535 - Surface Raceways for Electrical Systems:
 - 1. Lay-in wireways and wiring troughs with removable covers.
- I. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- J. Section 262726 - Wiring Devices:
 - 1. Wall plates.
 - 2. Additional requirements for locating boxes for wiring devices.
- K. Section 270528 - Pathways for Low Voltage Systems Cabling: Additional requirements for communications systems outlet boxes.
- L. Section 271000 - Structured Cabling: Additional requirements for communications systems outlet boxes.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.
- C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
- E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013 (Reaffirmed 2020).
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. SCTE 77 - Specifications for Underground Enclosure Integrity; 2023.
- H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- J. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- K. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
 - 4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
 - 5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
 - 6. Coordinate the work with other trades to preserve insulation integrity.
 - 7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
 - 8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.

- B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- C. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, and underground boxes/enclosures.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Keys for Lockable Enclosures: Two of each different key.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Provide products listed with Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.
- C. Electrical boxes shall be sized accordingly to NEC requirements unless otherwise noted in contract documents.
- D. Maintain integrity of insulation materials where flush boxes are installed in insulated spaces.
- E. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 BOXES

- A. General Requirements:
 - 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
 - 2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 - 3. Provide products listed, classified, and labeled as suitable for the purpose intended.
 - 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
 - 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
 - 1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 - 2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.

3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
 4. Use cast aluminum boxes where aluminum rigid metal conduit is used.
 5. Use suitable concrete type boxes where flush-mounted in concrete.
 6. Use suitable masonry type boxes where flush-mounted in masonry walls.
 7. Use raised covers suitable for the type of wall construction and device configuration where required.
 8. Use shallow boxes where required by the type of wall construction.
 9. Do not use "through-wall" boxes designed for access from both sides of wall.
 10. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 11. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 12. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 13. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
 14. Minimum Box Size, Unless Otherwise Indicated:
 - a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
 - b. Communications Systems Outlets: Comply with Section 271000.
 - c. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.
 15. Wall Plates: Comply with Section 262726.
 16. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Hubbell Incorporated; Bell Products: www.hubbell-rtb.com/#sle.
 - c. Hubbell Incorporated; RACO Products: www.hubbell-rtb.com/#sle.
 - d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - e. ABB Installation Products: <https://electrification.us.abb.com>.
 - f. Appleton: <https://www.appleton.emerson.com/>
 - g. Substitutions: See Section 016000 - Product Requirements.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA EN 10250 Environment Type, Unless Otherwise Indicated:
 - a. Indoor Clean, Dry Locations: Type 1, painted steel.
 - b. Outdoor Locations: Type 3R, painted steel.
 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 - b. Boxes 6 square feet and Larger: Provide hinged-cover enclosures.
 4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
 - a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
 - b. Back Panels: Painted steel, removable(where applicable).
 5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
 6. Manufacturers:

- a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com/#sle.
 - c. Hubbell Incorporated; Wiegmann Products: www.hubbell-wiegmann.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- D. Electrical Outlet Box Pad:
- 1. Electrical outlet box pads shall be applied where called out on the drawings or specifications. Its function is to seal box openings, increase mass, and provide damping to reduce air-transmitted sound through party walls. It shall consist of polybutylene-butyl and inert fillers. Material shall provide good adhesion to metal and plastic. Pads shall be applied to the backs of installed electrical boxes, molded to box, and folded around conduit cable entering the box. Pads shall not be used in areas subject to temperatures above 200 degrees F.
 - 2. The following are acceptable, subject to the above:
 - a. FireStop Putty Pad (#CP617) from HILTI: www.hilti.com.
 - b. SpecSeal firestop putty pads (fire-rated) from Specified Technologies, Incorporated, Somerville: www.stifirestop.com.
 - c. Or approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- H. Box Locations:

1. Locate boxes to be accessible. Provide access panels in accordance with Section 083100 as required where approved by the Architect.
 - a. Adjust box locations up to 10 feet if required to accommodate intended purpose, at no additional cost to Owner.
 2. Locate boxes as required for devices installed under other sections or by others.
 - a. Switches, Receptacles, and Other Wiring Devices: Comply as indicated on drawings.
 - b. Communications Systems Outlets: Comply as indicated on drawings.
 3. Locate boxes so that wall plates do not span different building finishes.
 4. Locate boxes so that wall plates do not cross masonry joints.
 5. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
 6. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 24 inches horizontal separation unless otherwise indicated.
 7. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
 - b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
 8. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 260534.
 9. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
 - a. Concealed above accessible suspended ceilings.
 - b. Within joists in areas with no ceiling.
 - c. Electrical rooms.
 - d. Mechanical equipment rooms.
- I. Box Supports:
1. Secure and support boxes in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
 3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
 4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.
- J. Install boxes plumb and level.
- K. Flush-Mounted Boxes:

1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- L. Floor-Mounted Cabinets: Mount on properly sized 3 inch high concrete pad constructed in accordance with Section 033000.
- M. Install boxes as required to preserve insulation integrity.
- N. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- O. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- P. Close unused box openings.
- Q. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use. Wall plate material shall match that specified in Section 262726 for Wiring Devices.
- R. Provide grounding and bonding in accordance with Section 260526.
- S. Identify boxes in accordance with Section 260553.
1. Adjust box locations up to 10 feet if required to accommodate intended purpose, at no additional cost to Owner.
- T. Orient boxes to accommodate wiring device orientation as specified in Section 262726.
- U. Maintain headroom and present neat mechanical appearance.
- V. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- W. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- X. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
- Y. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
- Z. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
1. Acoustic rated walls.
 - a. In a single stud wall, there shall be a separation of 24 inches between centerlines of outlet boxes or receptacles set into opposite sides of the wall. When these boxes are of dimensions exceeding 4 inches wide, this dimension (24 inches) shall be

clear between the side walls, providing a full 24-inch separation regardless of the box size. Conduit connecting such boxes shall be flexible and shall provide 6 inches slack per 24 inches of run.

- b. In a double stud wall, boxes in opposite sides of the wall shall be located 24 inches on center, minimum. Effectively, this means that boxes on the same side of the wall will be 48 inches apart if there is a box between them on the other side of the wall. Conduit, in the case of a double wall, shall home run to a point outside of the partition before connecting to cable and conduit connecting boxes on the other side. Conduit, which shall be flexible, may thread through the studs on its own side but shall under no circumstances interface with the stud on the other side of the wall.
- c. The boxes shall be treated to reduce sound transmission. All unused knock-out holes shall be plugged with knock-out caps. The openings or cutouts in the walls to receive the boxes/receptacles shall be made no more than 1-1/4 inches oversize to allow a gap all around of 1-1/8 inches. The flanges shall be perimeter sealed with acoustical caulking, prior to the boxes/receptacles being inserted.
- d. An outlet box pad, which acts to increase mass and provides damping, shall be applied to the backs of back-to-back electrical boxes separated by less than 24 inches, or where the box is installed in acoustical barrier walls. Refer to architectural wall types.

AA. Use stamped steel bridges to fasten flush mounting outlet box between studs.

BB. Use adjustable steel channel fasteners for hung ceiling outlet box.

CC. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.

DD. Locate outlet boxes so that the wall plates do not cross masonry joints or span different building finishes.

3.3 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

B. Clean exposed surfaces and restore finishes.

3.4 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

3.5 INTERFACE WITH OTHER PRODUCTS

A. Coordinate installation of outlet box with products furnished under other sections of these specifications.

B. Coordinate locations and sizes of required access doors.

C. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

- D. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes with architectural drawings.

END OF SECTION

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.

1.2 RELATED REQUIREMENTS

- A. Section 099113 - Exterior Painting.
- B. Section 099123 - Interior Painting.
- C. Section 260001 - Basic Electrical Materials and Methods.
- D. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- E. Section 262726 - Wiring Devices: Device and wallplate finishes; factory pre-marked wallplates.
- F. Section 270528 - Pathways for Low Voltage Systems Cabling: Additional requirements for communications systems outlet boxes.
- G. Section 271000 - Structured Cabling: Identification for communications cabling and devices.

1.3 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. NFPA 70E - Standard for Electrical Safety in the Workplace; 2027.
- C. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
 - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.

2. Do not install identification products until final surface finishes and painting are complete.

1.5 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.6 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

- A. Existing Work: Unless specifically excluded, identify existing elements to remain whose designations are changed as part of the new work.
- B. Identification for Equipment:
 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Switchboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source.
 - 4) Use identification nameplate to identify main overcurrent protective device.
 - 5) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - 6) Available fault current noting phase(s) and kA (kilo-Amps).
 - b. Panelboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source.
 - 4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
 - 5) Use computer generated circuit directory to update and identify load(s) served for panelboards with a door. Identify spares and spaces. Identify load type, circuit number, breaker size and number of poles, and circuit load in volt-amps.
 - 6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - c. Transformers:
 - 1) Identify kVA rating.
 - 2) Identify voltage and phase for primary and secondary.
 - 3) Identify power source.
 - 4) Identify load(s) served.

- d. Enclosed switches, circuit breakers, and motor controllers:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number.
 - 3) Identify load(s) served.
- e. Lighting relay control devices (room controllers):
 - 1) Provide label on device indicating for each relay the relay number, power panel name, and circuit number.
- f. Time Switches:
 - 1) Identify load(s) served and associated circuits controlled. Include location.
- g. Enclosed Contactors:
 - 1) Identify voltage and phase.
 - 2) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
 - 3) Identify coil voltage.
 - 4) Identify load(s) and associated circuits controlled. Include location.
- 2. Service Equipment:
 - a. Use identification nameplate to identify each service disconnecting means.
 - b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.
 - c. Use identification nameplate or identification label at each piece of service equipment to identify available fault current and the date calculations were performed.
- 3. Emergency System Equipment:
 - a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
 - b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
 - c. Use identification nameplate to identify emergency operating instructions for emergency system equipment.
- 4. Use voltage marker to identify highest voltage present for each piece of electrical equipment with voltage 480 V or higher.
- 5. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
- 6. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
- 7. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70 including but not limited to the following.
 - a. Service equipment.
 - b. Industrial control panels.
 - c. Motor control centers.
 - d. Elevator control panels.
 - e. Industrial machinery.

Identification for Electrical Systems

8. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
 - a. Minimum Size: 5 by 7 inches.
 - b. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.
- C. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 260519.

<u>Less than 250 Volts Between Phases</u>
Phase A - Black
Phase B - Red
Phase C - Blue
Neutral - White
Ground - Green
 2. Identification for Communications Conductors and Cables: Comply with Section 27 13 43.
 3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
 - a. At each source and load connection.
 - b. Within boxes when more than one circuit is present.
 - c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
 4. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
- D. Identification for Boxes:
1. Use voltage markers or color coded boxes to identify specified systems.
 - a. Color-Coded Boxes: Field-painted in accordance with Section 099123 and 099113 per the following color code:
 - 1) Fire Alarm System: Red.
 - b. For exposed boxes in public areas, do not color code.
 2. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
 - a. For exposed boxes in public areas, provide identification on inside face of cover.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
1. Manufacturers:
 - a. Brimar Industries, Inc: www.brimar.com/#sle.
 - b. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - c. Seton Identification Products: www.seton.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.

2. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
 3. Plastic Nameplates: Two-layer or three-layer laminated electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 - a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
 4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
 5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
 6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- B. Identification Labels:
1. Manufacturers:
 - a. Brady Corporation: www.bradyid.com/#sle.
 - b. Brother International Corporation: www.brother-usa.com/#sle.
 - c. Panduit Corp: www.panduit.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

2.3 WIRE AND CABLE MARKERS

- A. Manufacturers:
1. Brady Corporation: www.bradyid.com/#sle.
 2. HellermannTyton: www.hellermannntyton.com/#sle.
 3. Substitutions: See Section 016000 - Product Requirements.
- B. Markers for Conductors and Cables:
1. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- D. Legend: Power source and circuit number or other designation indicated.
- E. Text: Use factory pre-printed or machine-printed text, all capitalized. Do not use hand written text.
- F. Minimum Text Height: 1/8 inch.
- G. Color: Black text on white background unless otherwise indicated.

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 - 1. Surface-Mounted Equipment: Enclosure front.
 - 2. Flush-Mounted Equipment: Inside of equipment door or enclosure front.
 - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 - 4. Elevated Equipment: Legible from the floor or working platform.
 - 5. Branch Devices: Adjacent to device.
 - 6. Interior Components: Legible from the point of access.
 - 7. Conduits: Legible from the floor.
 - 8. Boxes: Outside face of cover.
 - 9. Conductors and Cables: Legible from the point of access.
 - 10. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws, rivets, self-adhesive backing, or epoxy cement and to interior surfaces using self-adhesive backing or epoxy cement.
 - 1. Do not use adhesives on exterior surfaces except where substrate cannot be penetrated.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Install underground warning tape above buried lines with one tape per trench at 6 inch(es) below finished grade. For trenches over 18 inches wide, install additional marker tape such that they are not over 10 inches apart (edge to edge) over the entire width of the trench.
- G. Secure rigid signs using stainless steel screws.
- H. Mark all handwritten text, where permitted, to be neat and legible.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

WIRING CONNECTIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical connections to equipment.

1.2 RELATED REQUIREMENTS

- A. Section 260001 - Basic Electrical Materials and Methods.
- B. Section 260519 - Low-Voltage Electrical Power Conductors and Cables.
- C. Section 260534 - Conduit for Electrical Systems.
- D. Section 260537 - Boxes for Electrical Systems.
- E. Section 262726 - Wiring Devices.
- F. Section 262818 - Enclosed Switches.

1.3 REFERENCE STANDARDS

- A. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2020).
- B. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2021.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
 - 2. Determine connection locations and requirements.
 - 3. Conduit, wire and circuit breaker sizes for mechanical equipment and equipment furnished under other Divisions are based on the equipment ratings of one manufacturer. The equipment actually furnished may have different electrical characteristics. Conduit, wire, and circuit breakers shall not be ordered or installed until exact electrical requirements are obtained. Responsibility for this coordination shall rest with the Contractor.
 - 4. Verify special purpose outlet NEMA configuration and ampere rating with equipment supplier prior to ordering devices and coverplates.
- B. Sequencing:
 - 1. Install rough-in of electrical connections before installation of equipment is required.
 - 2. Make electrical connections before required start-up of equipment.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
 - 1. Colors: Comply with NEMA WD 1.
 - 2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
 - 3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
- B. Enclosed Switches: As specified in Section 262818.
- C. Wiring Devices: As specified in Section 262726.
- D. Flexible Conduit: As specified in Section 260534.
- E. Wire and Cable: As specified in Section 260519.
- F. Boxes: As specified in Section 260537.

2.2 EQUIPMENT CONNECTIONS

- A. As indicated on drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION

LIGHTING CONTROL SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Section includes a networked lighting control system comprised of the following components:
 - 1. System Software Interfaces:
 - a. Management Interface.
 - b. Historical Database and Analytics Interface.
 - 2. System Backbone and Integration Equipment:
 - a. System Controller.
 - b. OpenADR Interface.
 - 3. Wired Networked Devices:
 - a. Wall Stations.
 - b. Graphic Wall Stations.
 - c. Digital Key Switches.
 - d. Auxiliary Input/Output Devices.
 - e. Occupancy and Photocell Sensors.
 - f. Wall Switch Sensors.
 - g. Power Packs and Secondary Packs.
 - h. Communication Bridge.
- B. The networked lighting control system shall meet all of the characteristics and performance requirements specified herein.
- C. The contractor shall provide, install and verify proper operation of all equipment necessary for proper operation of the system as specified herein and as shown on applicable drawings.

1.2 RELATED REQUIREMENTS

- A. Section 260001 - Basic Electrical Materials and Methods.
- B. Section 260534 - Conduit for Electrical Systems.
- C. Section 260537 - Boxes for Electrical Systems: Switch outlets and installation of switch devices.
- D. Section 262416 - Panelboards.
- E. Section 262726 - Wiring Devices.

1.3 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.

- B. Product Data: Provide data showing dimensions and ratings for components.
- C. Shop Drawings: Indicate wiring diagrams of system, showing interface with branch circuit wiring.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual locations of components and record circuiting and switching arrangements, including network device addresses.
- F. Maintenance Data: Include replacement parts numbers.

1.5 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. ETL & ETLc Approvals: The control panels shall be tested and listed under the UL 916 Energy Management Equipment standards and CSA C22.2 #205 by a nationally recognized testing laboratory.
- C. NEC Compliance: The control system shall comply with all applicable National Electrical Codes regarding electrical wiring standards.
- D. NEMA Compliance: The control system shall comply with all applicable portions of the NEMA standards regarding the types of electrical equipment enclosures.
- E. Component Pre-testing: All control equipment shall undergo strict inspection standards. The equipment shall be previously tested and burned-in at the factory prior to installation.
- F. System Checkout: A factory trained technician or factory authorized personnel or contractor shall functionally test the control system and verify performance after installation.
- G. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- H. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of design: Acuity Controls; <https://nlight.acuitybrands.com>
- B. Intelligent Lighting Controls: <https://www.ilc-usa.com/>.
- C. Hubbell NX Distributed Lighting Controls; www.hubbell.com/hubbellcontrolsolutions
- D. Substitutions: See Section 016000 - Product Requirements.

2.2 SYSTEM PERFORMANCE REQUIREMENTS

A. System Architecture:

1. System shall have an architecture that is based upon three main concepts: (1) networkable intelligent lighting control devices, (2) standalone lighting control zones using distributed intelligence, (3) optional system backbone for remote, time based and global operation between control zones.
2. Intelligent lighting control devices shall have individually addressable network communication capability and consist of one or more basic lighting control components: occupancy sensor, photocell sensor, relay, dimming output, contact closure input, analog 0-10V input, and manual wall station capable of indicating switching, dimming, and/or scene control. Combining one or more of these components into a single device enclosure shall be permissible so as to minimize overall device count of system.
3. Lighting control zones consisting of one or more intelligent lighting control devices shall be capable of providing automatic control from sensors (occupancy and/or photocell) and manual control from local wall stations without requiring connection to a higher-level system backbone; this capability is referred to as “distributed intelligence.”
 - a. Lighting control zones of at least 128 devices per zone shall be supported.
4. Intelligent lighting control devices shall support individual (unique) configuration of device settings and properties, with such configuration residing within the networked luminaires and intelligent control devices.
5. Intelligent lighting control devices shall have distributed intelligence programming stored in non-volatile memory, such that following any loss of power the lighting control zones shall operate according to their defined default settings and sequence of operations.
6. Lighting control zones shall be capable of being networked with a higher-level system backbone to provide time based control, remote control from inputs and/or systems external to the control zone, and remote configuration and monitoring through a software interface.
7. The system may include one or more system controllers that provide time-based control and global system control across multiple control zones and backbone network segments. The system controller also provides a means of connecting the lighting control system to a system software interface and building management systems via BACnet/IP or BACnet MS/TP protocol.
8. The system may include “communication bridge” devices that route communication from lighting control zones to and from the system controller, for purposes of decreasing system wiring requirements.
9. All system devices shall support remote firmware update, such that physical access to each device is not necessary, for purposes of upgrading functionality at a later date.

B. Wired Networked Control Zone Characteristics:

1. Following proper installation and provision of power, all networked devices connected together with low voltage network cable shall automatically form a functional lighting control zone without requiring any type of programming, regardless of the programming mechanism (e.g., software application, handheld remote, pushbutton). The “out of box” default sequence of operation is intended to provide typical sequence of operation so as to minimize the system startup and programming requirements and to also have functional lighting control operation prior to system startup and programming.
2. Once software is installed, system shall be able to automatically discover all connected devices without requiring any provisioning of system or zone addresses.

3. All networked devices shall have the ability to detect improper communication wiring and alert installation/startup personnel.
- C. System Integration Capabilities:
1. The system shall have the capability to interface with third party building management systems (BMS) to support two-way communication using the industry standard BACnet/IP or BACnet MS/TP protocols. The following system integration capabilities shall be available via BACnet/IP and BACnet MS/TP protocols:
 - a. The system shall have the capability to support control of individual devices, including, but not limited to, control of relay and dimming output.
 - b. The system shall support reading of individual device status information. The available status will depend on the individual device type and capabilities, which may include but not be limited to, relay state, dimming output, power measurement, occupancy sensor status, and photocell sensor states or readings. All system devices shall be available for polling for devices status.
 - c. The system shall support activation of pre-defined system Global Profiles (see Supported Sequence of Operations for further definition of Global Profile capabilities).
 2. The system shall support activation of Profiles (local or global) and Preset Scenes from third party systems by receiving dry contact closure output signals or digital commands via RS-232/RS-485. (See Supported Sequence of Operations for further definition of Profile and Scene Preset capabilities.)
 3. The system shall be capable of expansion to support activation of demand response levels from Demand Response Automation Servers (DRAS).
- D. Supported Sequence of Operations:
1. Characteristics and performance requirements herein shall be supported by the networked lighting control system.
 2. Control Zones:
 - a. Intelligent lighting control devices installed in an area (also referred to as a group of devices) shall be capable of transmitting and tracking occupancy sensor, photocell sensor, and manual switch information within at least 48 unique control zones to support different and reconfigurable sequences of operation within the area. These shall also be referred to as local control zones.
 - b. Intelligent lighting control devices located in different areas shall be able to transmit and track information within at least 128 system-wide control zones to support required sequences of operation that may span across multiple areas. Occupancy and photocell commands shall be available across a single controller, and switch commands shall be available across single or multiple controllers. These shall also be referred to as global control zones.
 3. Wall station Capabilities:
 - a. Wall stations shall be provided to support the following capabilities:
 - 1) On/Off of a local control zone and global control zone simultaneously, as required.
 - 2) Continuous dimming control of light level of a local control zone and global control zone simultaneously, as required.
 - 3) Preset Scenes that can activate a specific combination of light levels across multiple local and global channels, as required.
 - 4) Profile Scenes that can modify the sequence of operation for the devices in the area (group) in response to a button press. This capability is defined as

- supporting “Local Profiles” and is used to dynamically optimize the occupant experience and lighting energy usage. Wall stations shall be able to manually start and stop Local Profiles, or the local profile shall be capable of ending after a specific duration of time between 5 minutes and 12 hours. Parameters that shall be configurable and assigned to a Local Profile shall include, but not be limited to, fixture light level, occupancy time delay, response to occupancy sensors (including enabling/disabling response), response to daylight sensors (including enabling/disabling response), and enabling/disabling of wall stations.
- b. 3-way / multi-way control: multiple wall stations shall be capable of controlling the same local and global control zones, so as to support “multi-way” switching, dimming, preset scene, and profile scene control.
4. Occupancy Sensing Capabilities:
- a. Local and global control: Occupancy sensors shall be configurable to control a local and global zone simultaneously, as required.
 - b. Multi-sensor control: multiple occupancy sensors shall be capable of controlling the same local and global control zones. This capability combines occupancy sensing coverage from multiple sensors without consuming multiple control zones.
 - c. System shall support the following types of occupancy sensing sequence of operations:
 - 1) On/Off Occupancy Sensing.
 - 2) Partial-On Occupancy Sensing.
 - 3) Partial-Off Occupancy Sensing.
 - 4) Vacancy Sensing (Manual-On / Automatic-Off).
 - d. On/Off, Partial-On, and Partial-Off Occupancy Sensing modes shall function according to the following sequence of operation:
 - 1) Occupancy sensors shall automatically turn lights on to a designated level when occupancy is detected. To support fine tuning of Partial-On sequences the designated occupied light level shall support at least 100 dimming levels.
 - 2) Occupancy sensors shall automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. To support fine tuning of Partial-Off sequences the designated unoccupied dim level shall support at least 100 dimming levels. To provide additional energy savings and an enhanced occupant experience, the system shall also be capable of dimming the lights when vacant and then turning the lights off completely after an additional amount of time.
 - 3) Photocell readings, if enabled in the Occupancy Sensing control zone, shall be capable of automatically adjusting the light level during occupied or unoccupied conditions as necessary to further reduce energy usage. Additional requirements and details for photocell sensing capabilities are indicated under Photocell Sensing Capabilities.
 - 4) At any time, the use of a wall station shall change the dimming level or turn lights off as selected by the occupant. The lights shall optionally remain in this manually-specified light level until the zone becomes vacant; upon vacancy the normal sequence of operation, as defined above, shall proceed.
 - e. Vacancy Sensing mode (also referred to as Manual-On / Automatic-Off) shall function according to the following sequence of operation:

- 1) The use of a wall station is required turn lights on. The system shall be capable of programming the zone to turn on to either to a designated light level or the previous user light level. Initially occupying the space without using a wall station shall not result in lights turning on.
- 2) Occupancy sensors shall automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. To support fine tuning of Partial-Off sequences the designated unoccupied dim level shall support at least 100 dimming levels. To provide additional energy savings and an enhanced occupant experience, the system shall also be capable of dimming the lights when vacant and then turning the lights off completely after an additional amount of time.
- 3) To minimize occupant impact in case the area or zone is still physically occupied following dimming or shutoff of the lights due to detection of vacancy, the system shall support an “automatic grace period” immediately following detection of vacancy, during which time any detected occupancy shall result in the lights reverting to the previous level. After the grace period has expired, the use of a wall station is required to turn lights on.
- 4) Photocell readings, if enabled in the Occupancy Sensing control zone, shall be capable of automatically adjusting the light level during occupied or unoccupied conditions as necessary to further reduce energy usage. Additional requirements and details for photocell sensing capabilities are indicated under Photocell Sensing Capabilities.
- 5) At any time, the use of a wall station shall change the dimming level or turn lights off as selected by the occupant. The lights shall optionally remain in this manually-specified light level until the zone becomes vacant; upon vacancy the normal sequence of operation, as defined above, shall proceed.
- f. To accommodate different types of environments, occupancy time delays before dimming or shutting off lights shall be specifiable for control zones between 15 seconds to 2 hours.
5. Photocell Sensing Capabilities (Automatic Daylight Sensing):
 - a. Photocell sensing devices shall be configurable to control a local and global zone simultaneously, as required.
 - b. The system shall support the following types of photocell-based control:
 - 1) On/Off: The control zone is automatically turned off if the photocell reading exceeds the defined setpoint and automatically turned on if the photocell reading is below the defined setpoint. An adjustable time delay or adaptive setpoint behavior may be used to prevent the system from exhibiting nuisance on/off switching, as well as a dead band to prevent on/off cycling.
 - 2) Continuous Dimming: The control zone automatically adjusts its dimming output in response to photocell readings, such that a minimum light level consisting of both electric light and daylight sources is maintained at the task. The photocell response shall be configurable to adjust the photocell setpoint and dimming rates.
6. Schedule and Global Profile Capabilities:
 - a. The system shall be capable of automatically modifying the sequence of operation for selected devices in response to any of the following: a time-of-day schedule, contact closure input state, manually triggered wall station input, RS-232/RS-485 command, and BACnet input command. This capability is defined as supporting “Global Profiles” and is used to dynamically optimize the occupant experience and lighting energy usage.

- b. Global profiles may be scheduled with the following capabilities:
 - 1) Global Profiles shall be stored within and executed from the system controller (via internal timeclock) such that a dedicated software host or server is not required to be online to support automatic scheduling and/or operation of Global Profiles.
 - 2) Global Profile time of day schedules shall be capable of being given the following recurrence settings: daily, specific days of week, every “n” number of days, weekly, monthly, and yearly. Lighting control profile schedules shall support definition of start date, end date, end after “n” recurrences, or never ending. Daylight savings time adjustments shall be capable of being performed automatically, if desired.
 - 3) Global Profile Holiday Schedules should follow recurrent settings for specific US holiday dates regardless if they always occur on a specific date or are determined by the day/week of the month.
 - 4) Global Profiles shall be capable of being scheduled to run according to timed offsets relative to sunrise or sunset. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.
 - 5) System shall support blink warning and timed extension capabilities. At the end of a scheduled period, the system shall be capable of providing a visible “blink warning” 5 minutes prior to the end of the schedule. Wall stations may be programmed to provide timed overrides that turn the lights on for an additional period of time. Timed override duration shall be programmable for each individual device, zone of devices, or customized group of devices, ranging from 5 minutes to 12 hours.
 - 6) Software management interface shall be capable of displaying a graphic calendar view of profile schedules for each control zone.
 - c. System Global Profiles shall have the following additional capabilities:
 - 1) Global Profiles shall be capable of being manually activated directly from the system controller, specially programmed input devices, scene capable wall stations, and the software management interface.
 - 2) Global Profiles shall be selectable to apply to a single device, zone of devices, or customized group of devices.
 - 3) Parameters that shall be configurable and assigned to a Global Profile shall include, but not be limited to, fixture light level, occupancy time delay, response to occupancy sensors (including enabling/disabling response), response to daylight sensors (including enabling/disabling response), and enabling/disabling of wall stations.
 - d. A backup of Local and Global Profiles shall be stored on the software’s host server such that the Profile backup can be applied to a replacement system controller or wall station.
7. System shall support automated demand response capabilities with automatic reduction of light level to at least three levels of demand response.

2.3 SYSTEM SOFTWARE INTERFACES

A. Management Interface:

- 1. System shall provide a web-based management interface that provides remote system control, live status monitoring, and configuration capabilities of lighting control settings and schedules.

- a. Management interface must be compatible with industry-standard web browser clients, including, but not limited to, Microsoft Internet Explorer®, Apple Safari®, Google Chrome®, Mozilla Firefox®.
 - b. Management interface shall require all users to login with a User Name and Password, and shall support creation of at least 100 unique user accounts.
 - c. Management interface shall support at least three permission levels for users: read-only, read & change settings, and full administrative system access.
 - d. Management interface shall be capable of restricting access for user accounts to specific devices within the system.
 - e. All system devices shall be capable of being given user-defined names.
 - f. The following device identification information shall be displayed in the Management interface: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.
 - g. Management interface shall be able to read the live status of a networked luminaire or intelligent control device and shall be capable of displaying luminaire on/off status, dim level, power measurement, device temperature, PIR occupancy sensor status, microphonic occupancy sensor status, remaining occupancy time delay, photocell reading, and active Scenes or Profiles.
 - h. Management interface shall be able to read the current active settings of a networked luminaire or intelligent control device and shall be capable of displaying dimming trim levels, occupancy sensor and photocell enable/disable, occupancy sensor time delay and light level settings, occupancy sensor response (normal or vacancy), and photocell setpoints and transition time delays.
 - i. Management interface shall be able to change the current active settings and default settings for an individual networked luminaire or intelligent control device.
 - j. Management interface shall be capable of applying settings changes for a zone of devices or a group of selected devices using a single “save” action that does not require the user to save settings changes for each individual device.
 - k. A printable network inventory report shall be available via the management interface.
 - l. A printable report detailing all system profiles shall be available via the management interface.
 - m. All sensitive information stored by the software shall be encrypted.
 - n. All system software updates must be available for automatic download and installation via the internet.
- B. Historical Database and Analytics Interface:
1. System shall provide a historical database that stores device operational history and calculates energy usage for all networked luminaires and intelligent control devices.
 2. System shall be capable of reporting lighting system events and performance data back to the historical database for display and analysis.
 3. Historical database shall be capable of recording historical data for up to 20,000 networked devices for a period of at least 1 calendar year.
 4. An “Energy Scorecard” shall be displayed that shows calculated energy savings in dollars, kWh, or CO₂.
 5. Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photocells, manual switching, etc.).
 6. Energy savings data shall be calculated for the system as a whole or for individual zones.

7. A time scaled graph showing all relay transitions shall be presented.
8. A time scaled graph showing a zones occupancy time delay shall be presented
9. A time scaled graph showing the total light level shall be presented.
10. User shall be able to customize the baseline run-time hours for a space.
11. User shall be able to customize up to four time-of-day billing rates and schedules.
12. Historical data shall be exportable from the Historical Database via a "CSV" type of file format.
13. Programming capabilities through the application shall include, but not be limited to, the following:
 - a. Switch/occupancy/photosensor group configuration.
 - b. Manual/automatic on modes.
 - c. Turn-on dim level.
 - d. Occupancy sensor time delays.
 - e. Dual technology occupancy sensors sensitivity.
 - f. Photosensor calibration adjustment and auto-setpoint.
 - g. Trim level settings.
 - h. Preset scene creation and copy for scene capable devices.
 - i. Application of a custom device label.

2.4 SYSTEM BACKBONE AND SYSTEM INTEGRATION EQUIPMENT

A. System Controller:

1. Product Series: nECY.
2. System Controller shall be multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.
3. System Controller shall have 32-bit microprocessor operating at a minimum of 1 GHz.
4. System Controller shall have minimum of 512MB memory, with a minimum of 4GB non-volatile flash, to support its own operating system and databases.
5. System Controller shall perform the following functions:
 - a. Time-based control of downstream wired and wireless network devices.
 - b. Facilitation of global network switch communication between different system controllers.
 - c. Linking into an Ethernet network.
 - d. Capable of integration with Building Management Systems (BMS) and Heating, Ventilation and Air Conditioning (HVAC) equipment.
 - e. Connection to various software interfaces, including management interface, historical database and analytics interface, visualization interface, and personal control applications.
6. System Controller shall have an integral web server to support configuration, diagnostics and hosting of software interfaces.
7. Provide with a graphical touch screen to support configuration and diagnostics.
8. Device shall have three RJ-45 networked lighting control ports for connection to any of the following:
 - a. The graphical touch screen.
 - b. Wired communication bridges.
 - c. Direct connection to intelligent lighting control devices (up to 128 total devices per port).
9. Device shall be capable of communicating with wireless network bridges and software interfaces via LAN connection.

10. Device shall automatically detect all networked devices connected to it, including those connected to communication bridges.
11. Device shall have a standard and astronomical internal time clock.
12. Device shall have 2 switched RJ-45 10/100 BaseT Ethernet ports for local area network (LAN) connection.
 - a. Ethernet connection shall support daisy chain wiring to other lighting control system LAN devices, such as other system controllers and wireless networked communication bridges.
 - b. Ethernet connection shall support IPv4 and shall be capable of using a dedicated static or DHCP assigned IP address.
13. Device shall have 2 x USB 2.0 Expansion ports for 802.11 Wi-Fi Adapter enabling wireless connectivity including:
 - a. Hot Spot.
 - b. Access Point.
 - c. Client.
14. System Controller shall be capable of managing and operating at least 750 networked devices (wired or wireless).
 - a. Multiple System Controllers may be networked together via LAN connection to scale the system up to 20,000 networked devices.
15. System Controller shall support BACnet/IP and BACnet MS/TP protocols to directly interface with BMS and HVAC equipment without the need for additional protocol translation gateways.
 - a. BACnet MS/TP shall support 9600 to 115200 baud rate.
 - b. System Controller shall be BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.
16. System controller shall contain a "FIPS 140-2 Level 1 Inside" cryptographic module.
17. System controlled shall be available within a NEMA 1 enclosure with Class 1 and Class 2 separation.
 - a. Enclosure shall support power input power of 120-277VAC, or optional 347VAC.

B. OpenADR Interface:

1. Product Series: nADR.
2. System shall provide an interface to OpenADR protocol Demand Response Automation Servers (DRAS) typically provided by local electrical utility.
3. OpenADR interface shall meet all the requirements of Open ADR 2.0a Virtual End Nodes (VEN), including:
 - a. Programmable with the account information of the end-user's electrical utility DRAS account credentials.
4. OpenADR interface shall support the activation of demand response levels defined in the utility demand response program.

2.5 WIRED NETWORKED DEVICES

A. Wired Networked Wall Switches, Dimmers, Scene Controllers:

1. Product Series: nPODM, nPODM xS, nPODM xL.
2. Devices shall recess into single-gang switch box and fit a standard GFI opening.
3. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.

4. All switches shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
 5. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
 6. Devices with mechanical push-buttons shall be made available with custom button labeling.
 7. Wall switches & dimmers shall support the following device options:
 - a. Number of control zones: 1, 2 or 4.
 - b. Control Types Supported:
 - 1) On/Off.
 - 2) On/Off/Dimming.
 - c. Colors: Ivory, White, Light Almond, Gray, Black, Red.
 - d. Wall Plates: See specification section 262726 - Wiring Devices.
- B. Wired Networked Graphic Wall Stations:
1. Product Series: nPOD-GFX.
 2. Device shall surface mount to single-gang switch box.
 3. Device shall have a 3.5" full color touch screen.
 4. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply.
 5. Device shall have a micro-USB style connector for local computer connectivity.
 6. Communication shall be over standard low voltage network cabling with RJ-45 connectors.
 7. Device shall enable user supplied screen saver image to be uploaded within one of the following formats: jpg, png, gif, bmp, tif.
 8. Device shall enable configuration of all switches, dimmers, and lighting preset scenes via password protected setup screens.
 9. Graphic wall stations shall support the following device options:
 - a. Number of control zones: Up to 16.
 - b. Number of scenes: Up to 16.
 - c. Profile type scene duration: User configurable from 5 minutes to 12 hours.
 - d. Colors: Ivory, White, Light Almond, Gray, Black.
- C. Wired Networked Digital Key Switches:
1. Product Series: nPOD KEY.
 2. Devices shall recess into single-gang switch box and fit a standard GFI opening.
 3. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
 4. All switches shall have the ability to detect when it is not receiving valid communication and visually indicate a potential wiring issue.
 5. Devices shall have LED user feedback to provide indication of on/off status of the programmed lights or scene, as well as indication of device power.
 6. Digital key switches shall support the following device options:
 - a. Control Types Supported:
 - 1) On/Off.
 - 2) On/Off/Dimming.
 - b. Colors: White.
 - c. Wall Plates: See specification section 262726 - Wiring Devices.
- D. Wired Networked Auxiliary Input / Output (I/O) Devices:

1. Product Series: nIO-1S, nIO-RLX, nIO-MLO-5STEPA, nIO-MLO-AB, nIO-NLI, nIO-X, nIO-D, nIO-EZ-PH, nIO-EZD.
 2. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½” knockout.
 3. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
 4. Auxiliary Input/Output Devices shall be specified as an input or output device with the following options:
 - a. Contact closure or Pull High input:
 - 1) Input shall be programmable to support maintained or momentary inputs that can activate local or global scenes and profiles, activate lights at a preconfigured level, ramp light level up or down, or toggle lights on/off.
 - b. 0-10V analog input:
 - 1) Input shall be programmable to function as a daylight sensor.
 - c. RS-232/RS-485 digital input:
 - 1) Input supports activation of up to 4 local or global scenes and profiles, and on/off/dimming control of up to 16 local control zones.
 - d. 0-10V dimming control output, capable of sinking up to 20mA of current:
 - 1) Output shall be programmable to support all standard sequence of operations supported by system.
 - e. Digital control output via EldoLED LEDcode communication:
 - 1) Output shall be programmable to support light intensity control, as well as optional correlated color temperature (CCT) control, of the connected luminaire.
- E. Wired Networked Occupancy and Photosensors:
1. Product Series: nCM.
 2. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
 3. Sensors shall be dual-technology type and utilize passive infrared (PIR) and microphonic (or ultrasonic) technology, to detect occupant presence.
 4. Sensors shall be either ceiling mounted or networked embedded into light fixture. See drawings for designated locations.
 5. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
 6. All sensors shall have the ability to detect when it is not receiving valid communication and visually indicate a potential wiring issue.
 7. Sensor programming parameter shall be available and configurable remotely from the software and locally via the device push-button.
 8. Ceiling mount occupancy sensors shall be available with zero or one integrated dry contact switching relays, capable of switching 1 amp at 24 VAC/VDC (resistive only).
 9. Sensors shall be available with one or two occupancy “poles”, each of which provides a programmable time delay.
 10. Sensors shall have optional features for photosensor/daylight override, automatic dimming control, and low temperature/high humidity operation.
 11. Photosensor shall provide for an on/off set-point, and a dead band to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
 12. Photosensor and dimming sensor’s set-point and dead band shall be automatically calibrated through the sensor’s microprocessor by initiating an “Automatic Set-point

Programming” procedure. Min and max dim settings as well as set-point may be manually entered.

13. Dead band setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
14. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The secondary daylight zone shall be capable of being controlled as an “offset” from the primary zone.

F. Wired Networked Wall Switch Sensors:

1. Product Series: nWSX.
2. Devices shall recess into single-gang switch box and fit a standard GFI opening.
3. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
4. All wall switch sensors shall have the ability to detect when it is not receiving valid communication and visually indicate a potential wiring issue.
5. Devices with mechanical push-buttons shall provide tactile user feedback.
6. Wall switches sensors shall support the following device options:
 - a. User Input Control Types Supported: On/Off or On/Off/Dimming.
 - b. Occupancy Sensing Technology: Dual Technology type.
 - c. Colors: White.
 - d. Wall Plates: See specification section 262726 - Wiring Devices.

G. Wired Networked Embedded Sensors:

1. Embedded sensors shall support the following device options:
 - a. Occupancy Sensing Technology: Dual Tech.
 - b. Daylight Sensing Option: Occupancy only, Daylight only, or combination Occupancy/Daylight sensor. See Drawings for sensor type / function setting.

H. Distributed System Power, Switching, and Dimming Controls:

1. Devices shall incorporate one optional Class 1 relay, optional 0-10 VDC dimming output, and contribute low voltage Class 2 power to the rest of the system.
2. Device programming parameters shall be available and configurable remotely from the software and locally via the device push-button.
3. Device shall be plenum rated.
4. Devices shall be UL Listed for load and load type as specified on the plans.

I. Wired Networked Luminaires:

1. Networked luminaire shall have a factory installed mechanically integrated control device and carry a UL Listing as required.
2. Networked LED luminaire shall provide low voltage power to other networked control devices.
3. System shall be able to maintain constant lumen output over the specified life of the LED luminaire (also called lumen compensation) by automatically varying the dimming control signal to account for lumen depreciation.
4. System shall be able to provide control of network luminaire intensity, in addition to correlated color temperature of specific LED luminaires.
5. Controls manufacturer is responsible for primary troubleshooting and tech support of complete fixture.

J. Wired Networked Communication Bridge:

1. Product Series: nBRG.
2. Device shall surface mount to a standard 4" x 4" square junction box.
3. Device shall have 8 RJ-45 ports for connection to lighting control zones (up to 127 devices per port), additional network bridges, and System Controller.
4. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to System Controller.
5. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply, or powered via low voltage network connections from powered lighting control devices (e.g. power packs).
6. Wired Bridge shall be capable of redistributing power from its local supply and connected lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.

2.6 POWER LIMITED WIRE AND CABLE

- A. Per manufacturer's requirements.
- B. Provide plenum rated cable where routing in plenum spaces.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install wiring in the following locations in conduit in accordance with Section 260534:
 1. Within walls.
 2. Above inaccessible ceilings.
 3. Within hollow spaces used as air handling duct chases and plenums.
 4. Exposed along surfaces.
- B. Install relays to be accessible. Allow space for adequate ventilation and circulation of air.
- C. The control system shall be installed and fully wired by the installing contractor. The contractor shall complete all electrical connections to all control circuits, and wiring.
- D. Test low voltage network cable included in the bid. Verify the following minimum parameters:
 1. Wire Map (continuity, pin termination, shorts and open connections, etc.).
 2. Length.
 3. Insertion Loss.
- E. Coordination with Owner's IT Network Infrastructure:
 1. Coordinate with the owner's representative to secure all required network connections to the owner's IT network infrastructure.
 - a. Provide to the owner's representative all network infrastructure requirements of the networked lighting control system.
 - b. Provide to the manufacturer's representative all necessary contacts pertaining to the owner's IT infrastructure, to ensure that the system is properly connected and started up.

3.2 IDENTIFICATION

- A. See Section 260553 - Identification for Electrical Systems.

3.3 PRODUCT SUPPORT AND SERVICE

- A. Factory telephone support shall be available at no cost to the Owner.
- B. A minimum of 6 hours of on-site factory support shall be available at no cost to the Owner. Additional hours may be negotiated by the Contractor or Owner.
- C. Factory assistance shall consist of solving programming or application questions concerning the control equipment.

3.4 SYSTEM DELIVERY AND ACCEPTANCE

- A. The contractor is responsible for complete installation of the entire system according to strict factory standards and requirements:
 - 1. All system equipment shall operate in accordance with specification and industrial standard procedures.
 - 2. An operational user program shall exist in the control system. The program shall execute and perform all functions required to effectively operate the site.
 - 3. Demonstration of program integrity during normal operation and pursuant to a power outage.
 - 4. Contractor shall provide a minimum of six training hours on the operation and use of the control system and software. Additional support services shall be negotiated between the contractor and the building owner or manager.
- B. System start-up and programming shall include:
 - 1. Verifying operational communication to all system devices.
 - 2. Programming the network devices into functional control zones to meet the required sequence of operation.
 - 3. Programming and verifying all sequence of operations.
 - 4. Customization of owner's software interfaces and applications.
- C. Initial start-up and programming is to occur on-site. Additional programming may occur on-site or remotely over the Internet as necessary.
- D. System Documentation:
 - 1. Submit software database file with desired device labels and notes completed. Changes to this file will not be made by the factory.

3.5 WARRANTY

- A. Manufacturer shall supply a 2-year warranty on all hardware and software and shall cover repair or replacement of defective products within the warranty period.

END OF SECTION

PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Lighting and appliance panelboards.
- B. Overcurrent protective devices for panelboards.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 260001 - Basic Electrical Materials and Methods.
- C. Section 260526 - Grounding and Bonding for Electrical Systems.
- D. Section 260529 - Hangers and Supports for Electrical Systems.
- E. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 262813 - Fuses: Fuses for fusible switches and spare fuse cabinets.

1.3 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e, with Amendments (2022).
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- C. NECA 407 - Standard for Installing and Maintaining Panelboards; 2025.
- D. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- E. NEMA PB 1 - Panelboards; 2011.
- F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 1000V or Less; 2023.
- G. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.
- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

- J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- K. UL 67 - Panelboards; Current Edition, Including All Revisions.
- L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- M. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.
- N. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
- O. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.
- P. UL 1699 - Arc-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
 - 4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
- D. Field Quality Control Test Reports.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

- F. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Panelboard Keys: One for each panelboard installed.
 - 3. See Section 262813 for requirements for spare fuses and spare fuse cabinets.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. ABB/GE: www.electrification.us.abb.com/#sle.
- B. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
- C. Siemens Industry, Inc: www.usa.siemens.com/#sle.
- D. Substitutions: See Section 016000 - Product Requirements.
- E. Source Limitations: Provide panelboards and associated components produced by same manufacturer as other electrical distribution equipment used for project and obtained from a single supplier.

2.2 PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.

- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
 - 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- G. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 - 1. Provide fully rated neutral bus, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 - 2. Provide 200 percent rated neutral bus and lugs where oversized neutral conductors are provided.
 - 3. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
 - 4. Provide separate isolated/insulated ground bus where indicated.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.
- I. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
 - c. Provide removable end walls for NEMA Type 1 enclosures.
 - 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 - c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
 - 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

- K. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
 - 1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
 - 2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
 - a. Use zero sequence ground fault detection method unless otherwise indicated.
 - b. Provide test panel and field-adjustable ground fault pick-up and delay settings.
- L. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- M. Provide the following features and accessories where indicated or where required to complete installation:
 - 1. Feed-through lugs.
 - 2. Main breaker.
 - 3. Double lugs.

2.3 LIGHTING AND APPLIANCE PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 2. Main and Neutral Lug Type: Compression.
- C. Bussing:
 - 1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
 - 2. Phase and Neutral Bus Material: Copper.
 - 3. Ground Bus Material: Copper.
- D. Circuit Breakers: Thermal magnetic bolt-on type.
- E. Enclosures:
 - 1. Provide surface-mounted or flush-mounted enclosures as indicated.
 - 2. Fronts: Provide hinged door trim with hinged cover for access to load terminals and wiring gutters that are fastened closed with screws, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
 - 3. Provide circuit directory holder mounted on inside of door.

2.4 OVERCURRENT PROTECTIVE DEVICES

- A. Molded Case Circuit Breakers:
 - 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS

W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - 1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
3. Conductor Terminations:
 - a. Provide mechanical lugs for circuit breaker frame sizes less than 400 amperes.
 - b. Provide compression lugs for circuit breaker frame sizes 400 amperes and above.
 - c. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors of full breaker ampacity rating.
4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 - b. Provide interchangeable trip units where indicated.
5. For air conditioning equipment branch circuits provide circuit breakers UL listed as Type HACR.
6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
7. Provide the following circuit breaker types where indicated:
 - a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
 - b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
 - c. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699. Provide where required by applicable code.
8. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving lighting.
9. Do not use tandem circuit breakers.
10. Do not use handle ties in lieu of multi-pole circuit breakers.
11. Provide the following features and accessories where indicated or where required to complete installation:
 - a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
 - b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.

2.5 SOURCE QUALITY CONTROL

- A. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.

- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required support and attachment in accordance with Section 260529.
- F. Install panelboards plumb.
- G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- H. Mount panelboards such that the top of panelboard is 6 feet 6 inches above the floor or working platform. Install panelboards taller than 6 feet with bottom no more than 4 inches above the floor.
- I. Mount floor-mounted power distribution panelboards on properly sized 3 inch or 4 inch high concrete pad constructed in accordance with Section 033000.
- J. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling.
- K. Provide grounding and bonding in accordance with Section 260526.
 - 1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.
 - 2. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.
- L. Install all field-installed branch devices, components, and accessories.
- M. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.
- N. Set field-adjustable circuit breaker tripping function settings as required.
- O. Set field-adjustable ground fault protection pickup and time delay settings as required.
- P. Provide filler plates to cover unused spaces in panelboards.

- Q. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
 - 1. Emergency and night lighting circuits.
 - 2. Fire detection and alarm circuits.
 - 3. Communications equipment circuits.
 - 4. Intrusion detection and access control system circuits.
 - 5. Video surveillance system circuits.
- R. Identify panelboards in accordance with Section 260553.
 - 1. Provide computer generated circuit directory for each lighting and appliance panelboard and each power distribution panelboard provided with a door, clearly and specifically indicating the loads served. Identify spares and spaces.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Perform inspection, testing, and adjusting in accordance with Section 014000.
- C. Inspect and test in accordance with NETA ATS, except Section 4.
- D. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 800 amperes. Tests listed as optional are not required.
 - 1. Perform insulation-resistance tests on all control wiring with respect to ground.
 - 2. Test functions of the trip unit by means of secondary injection.
- E. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
 - 1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.
- F. Test GFCI circuit breakers to verify proper operation.
- G. Test AFCI circuit breakers to verify proper operation.
- H. Test shunt trips to verify proper operation.
- I. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.
- J. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.

- C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.5 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wall switches.
- B. Receptacles.
- C. Wall plates.
- D. Occupancy sensors (discrete "Line Voltage").

1.2 RELATED REQUIREMENTS

- A. Section 260001 - Basic Electrical Materials and Methods.
- B. Section 260537 - Boxes for Electrical Systems.
- C. Section 260535 - Surface Raceways for Electrical Systems: Surface raceway systems, including multioutlet assemblies.
- D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 260583 - Wiring Connections: Cords and plugs for equipment.

1.3 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for; 2014h (Validated 2022).
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification); 2017g (Validated 2023).
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- D. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.
- E. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2020).
- F. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2021.
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.
- I. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.

- J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
- K. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
 - 3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
 - 4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
 - 5. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.
- B. Sequencing:
 - 1. Do not install wiring devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- C. Samples: One for each type and color of device and wall plate specified.
- D. Field Quality Control Test Reports.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Operation and Maintenance Data:
 - 1. GFCI Receptacles: Include information on status indicators.
- G. Project Record Documents: Record actual installed locations of wiring devices.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Screwdrivers for Tamper-Resistant Screws: Two for each type of screw.
 - 3. Extra Keys for Locking Switches: Five of each type.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.1 WIRING DEVICE APPLICATIONS

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
- D. Provide tamper resistant receptacles for receptacles installed in locations as identified in NEC 406.12
 - 1. Child care, preschool, and education facilities.
 - 2. Assembly occupancies.
- E. Provide GFCI protection for receptacles installed within 6 feet of sinks, in all laundry areas, indoor wet locations, locker rooms with associated showering facilities.
- F. Provide GFCI protection for receptacles for 15A and 20A, 125V receptacles in non-dwelling type kitchens.
- G. Provide GFCI protection for receptacles serving electric drinking fountains.
- H. Unless noted otherwise, do not use combination switch/receptacle devices.

2.2 WIRING DEVICES

- A. Provide products listed and classified by Underwriter Laboratories, Inc. as suitable for the purpose specified and indicated.
- B. Source Limitations: Where possible, for each type of wiring device furnish products produced by a single manufacturer and obtained from a single supplier.
- C. Finishes:
 - 1. Provide wiring device finishes as described below unless otherwise indicated.
 - 2. Wiring Devices: Color as selected by the Architect with wall plate as specified in wall plates section.

3. Wiring Devices Installed in Finished Spaces: Color as selected by Architect with wall plate as specified in wall plates section.
4. Wiring Devices Installed in Unfinished Spaces: Color as selected by Architect with wall plate as specified in wall plates section.
5. Wiring Devices Installed in Wet or Damp Locations: Color as selected by Architect with specified weatherproof cover.
6. Wiring Devices Connected to Emergency Power: Red with wall plate as specified for wiring devices connected to normal power, but engraved "Emergency".

2.3 WALL SWITCHES

- A. Manufacturers:
 1. Hubbell Incorporated: www.hubbell.com/#sle.
 2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
 3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
 4. Cooper Wiring Devices: www.cooperwiringdevices.com.
 5. Substitutions: See Section 016000 - Product Requirements.
- B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
 1. Wiring Provisions: Terminal screws for side wiring with separate ground terminal screw.
- C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
 1. Products:
 - a. Hubbell 1221 Series.
 - b. Substitutions: See Section 016000 - Product Requirements.
- D. Pilot Light Wall Switches: Industrial specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
 1. Products:
 - a. Hubbell 1221 Series.
 - b. Substitutions: See Section 016000 - Product Requirements.
- E. Locking Wall Switches: Industrial specification grade, 20 A, 120/277 V with lever type keyed switch actuator and maintained contacts; switches keyed alike; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
 1. Products:
 - a. Hubbell 1221 Series.
 - b. Substitutions: See Section 016000 - Product Requirements.

2.4 RECEPTACLES

- A. Manufacturers:
 1. Hubbell Incorporated: www.hubbell.com/#sle.

2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
 3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
 4. Cooper Wiring Devices: www.cooperwiringdevices.com.
 5. Substitutions: See Section 016000 - Product Requirements.
- B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 2. NEMA configurations specified are according to NEMA WD 6.
 3. Hospital Grade Receptacles: Listed as complying with UL 498 Supplement SD, with green dot hospital grade mark on device face.
- C. Convenience Receptacles:
1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R and/or 15A, 125V, NEMA-15R ; single or duplex as indicated on the drawings.
 - a. Products:
 - 1) Hubbell 5362 (20A).
 - 2) Hubbell 5262 (15A).
 - 3) Substitutions: See Section 016000 - Product Requirements.
 2. Automatically Controlled Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R and/or 15A, 125V, NEMA-15R ; single or duplex as indicated on the drawings.
 - a. Products:
 - 1) Hubbell 5362 C1GRYTR (20A).
 - 2) Hubbell 5262 C1GRYTR (15A).
 - 3) Substitutions: See Section 016000 - Product Requirements.
 3. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R and/or 15A, 125V, NEMA-15R , listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
 - a. Products:
 - 1) Hubbell 5362WR (20A).
 - 2) Hubbell 5262WR (15A).
 - 3) Substitutions: See Section 016000 - Product Requirements.
 4. Tamper Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R and/or 15A, 125V, NEMA-15R , listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
 - a. Products:
 - 1) Hubbell BR20 Series (20A).
 - 2) Hubbell BR15 Series (15A).
 - 3) Substitutions: See Section 016000 - Product Requirements.
 5. Tamper Resistant and Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R and/or 15A, 125V, NEMA-15R , listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
 - a. Products:
 - 1) Hubbell BR20 Series (20A).

- 2) Hubbell BR15 (15A).
- 3) Substitutions: See Section 016000 - Product Requirements.

D. GFCI Receptacles:

1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
 - a. Provide test and reset buttons of same color as device.
2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R and/or 15A, 125V, NEMA-15R , rectangular decorator style.
 - a. Products:
 - 1) Hubbell GFR5362 Series (20A).
 - 2) Substitutions: See Section 016000 - Product Requirements.
3. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R and/or 15A, 125V, NEMA-15R , rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
 - a. Products:
 - 1) Hubbell GFR5362 Series (20A).
 - 2) Hubbell GFR5262 Series (15A).
 - 3) Substitutions: See Section 016000 - Product Requirements.
4. Tamper Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R and/or 15A, 125V, NEMA-15R , rectangular decorator style, listed and labeled as tamper resistant type.
 - a. Products:
 - 1) Hubbell GFTR20 Series (20A).
 - 2) Hubbell GFTR15 Series (15A).
 - 3) Substitutions: See Section 016000 - Product Requirements.
5. Tamper Resistant and Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R and/or 15A, 125V, NEMA-15R , rectangular decorator style, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
 - a. Products:
 - 1) Hubbell GFTR20 Series (20A).
 - 2) Hubbell GFTR15 Series (15A).
 - 3) Substitutions: See Section 016000 - Product Requirements.

E. Locking Receptacles: Industrial specification grade, configuration as indicated on the drawings.

1. Standard Locking Convenience Receptacles: Single, 20A, 125V, NEMA L5-20R.
 - a. Products:
 - 1) Hubbell 2310 Series.
 - 2) Substitutions: See Section 016000 - Product Requirements.

2.5 WALL PLATES

A. Manufacturers:

1. Hubbell Incorporated: www.hubbell-wiring.com/#sle.
2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.

3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
 4. Substitutions: See Section 016000 - Product Requirements.
- B. Wall Plates: Comply with UL 514D.
1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 2. Size: Standard.
 3. Screws: Metal with slotted heads finished to match wall plate finish.
 4. Provide screwless wallplates with concealed mounting hardware where indicated.
- C. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
- D. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.
1. Allowed only in electrical and mechanical equipment rooms, attic spaces and storage rooms.
- E. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

2.6 OCCUPANCY SENSORS (DISCRETE TYPE)

- A. Manufacturers:
1. Part numbers indicated are Acuity Controls; SensorSwitch: www.sensorswitch.acuitybrands.com; equals by other manufacturers are acceptable, provided they are the same manufacturer group as the Lighting Control System specified in Section 260918.
 2. Intelligent Lighting Controls: <https://www.ilc-usa.com/>.
 3. Hubbell Incorporated: www.hubbell-wiring.com.
 4. Substitutions: See Section 016000 - Product Requirements.
- B. Sensors to be dual technology type with integral 24-volt dry contact for use with energy management system, unless otherwise indicated.
- C. Sensors to have manual-on operation.
- D. Sensors to be provided with mounting as shown on drawings.
- E. The drawings show approximate locations of sensors and are diagrammatic only. Exact locations of detectors are to be field verified with the factory representative prior to mounting.
- F. Provide power pack as necessary for low voltage occupancy sensors.
- G. Wall Switch: SensorSwitch #WSXA-PTD-SA-WH Series.
1. Dual Technology:
 - a. Coverage area up to 1,000 sq. ft. with 180 degrees field of view.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- F. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 260537 as required for installation of wiring devices provided under this section.
 - 1. Mounting Heights: Unless otherwise indicated, as follows:
 - 2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 - 3. Where multiple receptacles or wall switches are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
 - 4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
 - 5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.

- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- I. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.
- J. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- K. Install wall switches with OFF position down.
- L. Do not share neutral conductor on branch circuits utilizing wall dimmers.
- M. Install vertically mounted receptacles with grounding pole on bottom and horizontally mounted receptacles with grounding pole on right.
- N. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- O. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- P. Identify wiring devices in accordance with Section 260553.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Perform field inspection, testing, and adjusting in accordance with Section 014000.
- C. Inspect each wiring device for damage and defects.
- D. Operate each wall switch with circuit energized to verify proper operation.
- E. Test each receptacle to verify operation and proper polarity.
- F. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- G. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.6 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

FUSES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fuses.

1.2 RELATED REQUIREMENTS

- A. Section 260001 - Basic Electrical Materials and Methods.
- B. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- C. Section 262818 - Enclosed Switches: Fusible switches.

1.3 REFERENCE STANDARDS

- A. NEMA FU 1 - Low Voltage Cartridge Fuses; 2012.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.
- D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses; Current Edition, Including All Revisions.
- E. UL 248-8 - Low-Voltage Fuses - Part 8: Class J Fuses; Current Edition, Including All Revisions.
- F. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses; Current Edition, Including All Revisions.
- G. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
 - a. Fusible Enclosed Switches: See Section 262818.
 - 2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Fuses: One set(s) of three for each type and size installed.
 - 3. Fuse Pullers: One set(s) compatible with each type and size installed.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Bussmann, a division of Eaton Corporation: www.cooperindustries.com/#sle.
- B. Littelfuse, Inc: www.littelfuse.com/#sle.
- C. Mersen: ep-us.mersen.com/#sle.
- D. Substitutions: See Section 016000 - Product Requirements.

2.2 APPLICATIONS

- A. Feeders:
 - 1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
 - 2. Fusible Switches Larger Than 600 Amperes: Class L, time-delay.
- B. Individual Motor Branch Circuits: Class RK1, time-delay.
- C. In-Line Protection for Pole-Mounted Luminaires: Class CC, time-delay.
- D. Primary Protection for Control Transformers: Class CC, time-delay.

2.3 FUSES

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.

- D. Comply with UL 248-1.
- E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
- F. Voltage Rating: Suitable for circuit voltage.
- G. Class R Fuses: Comply with UL 248-12.
- H. Class J Fuses: Comply with UL 248-8.
- I. Class L Fuses: Comply with UL 248-10.
- J. Class CC Fuses: Comply with UL 248-4.
- K. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- L. Provide the following accessories where indicated or where required to complete installation:
 - 1. Fuseholders: Compatible with indicated fuses.
 - 2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.
- B. Verify that mounting surfaces are ready to receive spare fuse cabinet.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.
- B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION

ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Enclosed safety switches.

1.2 RELATED REQUIREMENTS

- A. Section 260001 - Basic Electrical Materials and Methods.
- B. Section 260526 - Grounding and Bonding for Electrical Systems.
- C. Section 260529 - Hangers and Supports for Electrical Systems.
- D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 262813 - Fuses.

1.3 REFERENCE STANDARDS

- A. ANSI - American National Standards Institute; Current Edition, Including All Revisions.
- B. ASME - American Society of Mechanical Engineers; Current Edition, Including All Revisions.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- D. NEMA BS 31047 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013 (Reaffirmed 2023).
- E. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- F. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. NFPA 72 - National Fire Alarm and Signaling Code; Most Recent Edition Cited by Referring Code or Reference Standard.
- I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- K. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

- L. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories. Indicate voltage and current ratings.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- D. Project Record Documents: Record actual locations of enclosed switches.
- E. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. See Section 262813 for requirements for spare fuses and spare fuse cabinets.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Fusible / Non-Fusible Switches:
 - 1. Siemens Industry, Inc: www.usa.siemens.com/#sle.
- B. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between -22 degrees F and 104 degrees F.
- D. Horsepower Rating: Suitable for connected load.
- E. Voltage Rating: Suitable for circuit voltage.
- F. Short Circuit Current Rating:
 - 1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
 - 2. Minimum Ratings:
 - a. Heavy Duty Single Throw Switches Protected by Class R Fuses: 200,000 rms symmetrical amperes.
- G. Enclosed Safety Switches Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- H. Provide with switch blade contact position that is visible when the cover is open.
- I. Fuse Clips for Fusible Switches: As required to accept fuses indicated.

1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
- J. Conductor Terminations: Suitable for use with the conductors to be installed.
- K. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
- L. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- M. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.
 1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - c. Hose Down Areas: Type 4X.
 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
- N. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- O. Heavy Duty Switches:
 1. Comply with NEMA BS 31047.
 2. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Provide compression lugs where indicated.
 - c. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.
 - a. Provide means for locking handle in the ON position where indicated.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed safety switches.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.

- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 260529.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 260526.
- H. Provide fuses complying with Section 262813 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
- I. Identify enclosed switches in accordance with Section 260553.
- J. Furnish and install an enclosed switch at each motor and resistance heating equipment location.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Perform field inspection, testing, and adjusting in accordance with Section 014000.
- C. Inspect and test in accordance with NETA ATS, except Section 4.
- D. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
- E. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

- A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Luminaires.
- B. Drivers.
- C. Emergency power supply units.
- D. LED modules.

1.2 RELATED REQUIREMENTS

- A. Section 260001 - Basic Electrical Materials and Methods.
- B. Section 260529 - Hangers and Supports for Electrical Systems.
- C. Section 260526-Grounding and Bonding for Electrical Systems.
- D. Section 260537 - Boxes for Electrical Systems.
- E. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. IES LM-63 - Approved Method: IES Standard File Format for the Electronic Transfer of Photometric Data and Related Information; 2019 (Reaffirmed 2025).
- B. IES LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products; 2024.
- C. IES LM-80 - Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources; 2021.
- D. IESNA RP-8 - Roadway Lighting; 2014.
- E. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; 2025.
- F. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems; 2000 (Reaffirmed 2006).
- G. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; 2006.
- H. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2023.
- I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

- J. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- K. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.
- L. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- M. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
 - 2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
 - 3. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings:
 - 1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
 - 2. Provide photometric calculations where luminaires are proposed for substitution upon request.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
 - 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.
 - b. Include IES LM-79 test report upon request.
 - 2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IES LM-63 standard format upon request.
 - 3. LED Modules: Include rated life, color temperature, color rendering index (CRI), and initial and mean lumen output.
 - 4. Emergency Power Supply Unit: Include list of compatible lamp configurations and associated lumen output.
- D. Coefficients of Utilization by an approved testing laboratory.

- E. LED Module and driver type for each fixture.
- F. Group of fixtures with the same LED Module and driver type may reference a single set of submittal documents.
- G. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide 5-year manufacturer warranty for LED modules, including drivers.

PART 2 PRODUCTS

2.1 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Provide the complete system of lighting fixtures and LED Modules as shown on the drawings and specified herein. The requirements of all other sections of the specification are equally applicable to the work to be performed under this section.

- E. The fixture catalog numbers listed on the drawing indicate manufacturer, fixture design, appearance, etc., desired. These fixtures shall be modified if necessary to comply with the specification herein. Lighting fixtures specified will be the basis for comparison in the consideration of fixtures of other manufacturers.
- F. Fixture component parts shall be manufactured and/or assembled at the manufacturing plant for shipment in one or more packages. The shipment from the fixture manufacturer shall include integrally-mounted and/or remote-mounted drivers where drivers are required for the proper operation of the fixture lamps.
- G. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.
 - 2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
 - 3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.
- H. High Bay Luminaires: Provide safety chain or power hook unless otherwise indicated.
- I. Hazardous (Classified) Location Luminaires: Listed and labeled as complying with UL 844 for the classification of the installed location.
- J. Fixtures - General:
 - 1. Finish shall be white baked enamel, unless otherwise specified with a minimum average reflectance of 85% on exposed and light reflecting surfaces. Steel components shall be prepared for finishing with a 5-step zinc phosphatizing process.
 - 2. Surface mounted lighting fixtures shall have low density label.
 - 3. Recessed lighting fixtures installed in fire rated ceiling shall be provided with fire-rated protective covers.
 - 4. Fixtures mounted outdoors or in unheated spaces shall be capable of operating at 0 degrees F.
- K. If fixtures specified herein are discontinued at the time the work is executed, provide suitable substitute fixtures, without additional cost, as directed by the engineer.
- L. LED Luminaires:
 - 1. Components: UL 8750 recognized or listed as applicable.
 - 2. The Manufacturers required to inform the owner of new power requirements and / or lumen output values if new replacement components prior to shipping replacement parts.
 - 3. Color temperature shall be per the luminaire schedule. The color temperature shall not exceed a +/- tolerance of greater than 2 McAdam Ellipses. Over the life of the luminaire.
 - 4. Tested in accordance with IES LM-79 and IES LM-80.
 - 5. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.
- M. Track Lighting Systems: Provide track compatible with specified track heads, with connectors, power feed fittings, dead ends, hangers and canopies as necessary to complete installation.

- N. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with accessories required for joining and aligning.
- O. Electrical Characteristics: 120 volts, 60 Hz, unless otherwise specified.
- P. Substitutions, unless Otherwise Indicated: See Section 016000 - Product Requirements.

2.2 EMERGENCY POWER SUPPLY UNITS

- A. Manufacturers:
 - 1. As specified on the drawings or as recommended by light fixture manufacturer.
 - 2. Iota Engineering, LLC: www.iotaengineering.com/#sle.
- B. Description: Self-contained emergency power supply units suitable for use with indicated luminaires, complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
- C. Compatibility:
 - 1. Compatible with electronic, standard magnetic, energy saving, and dimming drivers.
- D. Operation: Upon interruption of normal power source, solid-state control automatically switches connected lamp(s) to the emergency power supply for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
- E. Battery: Sealed maintenance-free high-temperature nickel cadmium unless otherwise indicated.
- F. Diagnostics: Provide accessible and visible multi-chromatic combination test switch/indicator light to display charge, test, and diagnostic status and to manually activate emergency operation.
- G. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status and field selectable audible alert.
- H. Operating Temperature: From 32 degrees F to 122 degrees F unless otherwise indicated or required for the installed location.
- I. Accessories:
 - 1. Provide compatible accessory remote combination test switch/indicator light where indicated.

2.3 LED MODULES

- A. Manufacturers:
 - 1. As recommended by light fixture manufacturer..
 - 2. Substitutions: See Section 016000 - Product Requirements.
 - 3. Manufacturer Limitations: Where possible, provide lamps produced by a single manufacturer.

- B. LED Modules:
1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
 2. Verify compatibility of specified LED's with luminaires to be installed. Where LED's are not specified, provide LED's per luminaire manufacturer's recommendations.
 3. Minimum Efficiency: Provide LED's complying with all current applicable federal and state LED efficiency standards.
 4. Color Temperature Consistency: Unless otherwise indicated, for each type of LED furnish products which are consistent in perceived color temperature. Replace fixtures that are determined by the Architect to be inconsistent in perceived color temperature.
 5. Components: UL 8750 recognized or listed as applicable.
 6. Tested in accordance with IES LM-79 and IES LM-80.
 7. LED Estimated Useful Life: Minimum of 50,000 hours at 70% lumen maintenance, calculated based on IES LM-80 test data.
 8. Light Lumen output as indicated on the drawings.
 9. Interior lighting shall have a CRI of 80 or greater if not otherwise indicated on the drawings.
 10. Exterior lighting shall have a CRI of 70 or greater if not otherwise indicated on the drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 260537 as required for installation of luminaires provided under this section.
- B. Install products in accordance with manufacturer's instructions.
- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).

- D. Provide required support and attachment in accordance with Section 260529.
- E. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- F. Square and rectangular fixtures shall be mounted with sides parallel to building lines and parallel with ceiling lines.
- G. Properly support and align fixtures and provide necessary steel shapes for support of the fixtures. Recessed fixtures shall be supported at opposite corners by steel wire connected to building structure per IBC requirements. Coordinate complete fixture installation with the facility construction.
- H. Surface Mounted Fixtures: Where fixtures are indicated for installation on low density ceiling material, mount on ceiling spacers as recommended by manufacturer unless UL approved for mounting directly to ceiling material.
- I. Install accessories furnished with each luminaire.
- J. Bond products and metal accessories to branch circuit equipment grounding conductor.
- K. Emergency Power Supply Units:
 - 1. For field-installed units, install inside luminaire unless otherwise indicated. Where installation inside luminaire is not possible, install in remote location not exceeding manufacturer's recommended maximum conductor length to luminaire.
 - 2. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal driver(s) in luminaire. Bypass local switches, contactors, or other lighting controls.
 - 3. Install lock-on device on branch circuit breaker serving units.
- L. Remote Drivers: Install in accessible location as indicated or as required to complete installation, using conductors per manufacturer's recommendations not exceeding manufacturer's recommended maximum conductor length to luminaire.
- M. Identify luminaires connected to emergency power system in accordance with Section 260553.
- N. Operate light fixtures at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace light fixture components that fail prematurely.
- O. Verify ceiling systems and coordinate fixture type and accessories prior to ordering fixtures.
- P. Install light fixtures as recommended by the manufacturer or as necessary to provide exact horizontal alignment, preventing horizontal or vertical deflection, or angular jointing of fixtures installed in continuous rows.
- Q. All lighting fixtures shall be furnished complete with LED Module and driver and all accessories necessary to provide a complete operable fixture.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Test emergency power supply units to verify proper operation upon loss of normal power supply.
- E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy drivers as determined by Architect.

3.5 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

3.6 CLEANING

- A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals, for closeout submittals.
- B. See Section 017900 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.
- D. Just prior to Substantial Completion, replace defective LED Module(s) and driver(s).

3.8 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

PATHWAYS FOR LOW VOLTAGE SYSTEMS CABLING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Low voltage cabling systems pathways.
- B. Communications pathways.
- C. Pathway Identification.
- D. Pathways inside building(s).
- E. Enclosures, backboards, and outlet boxes.
- F. Grounding and bonding the low voltage cabling pathway system.

1.2 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 260001 - Basic Electrical Materials and Methods.
- C. Section 260526 - Grounding and Bonding for Electrical Systems.
- D. Section 260534 - Conduit.
- E. Section 260553 - Identification for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment; Consumer Electronics Association ; current version, with addenda.
- B. TIA-568.1 - Commercial Building Telecommunications Cabling Standard; Telecommunications Industry Association ; current version, with addenda..
- C. TIA-568.2 - Commercial Building Telecommunications Cabling Standard - Part 2: Balanced Twisted Pair Cabling Components; Telecommunications Industry Association ; current version, with addenda.
- D. TIA-568.3 - Commercial Building Telecommunications Cabling Standard - Part 3: Optical Fiber Cabling Components Standard; current version, with addenda.
- E. TIA-569 - Telecommunications Pathways and Spaces; current version, with addenda.
- F. TIA-606 - Administration Standard for Telecommunications Infrastructure, current version with addenda.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Keep stored products clean and dry.

1.5 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a 1 year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.1 SYSTEM DESIGN

- A. Provide a complete permanent system of cabling pathways for low-voltage system cabling including but not limited to: Voice and data communications, fire alarm, intercom/paging, clock, intrusion detection, access control, video surveillance, audio/visual, lighting controls and HVAC controls, including conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlet boxes.
- B. Drawings may indicate specific raceway requirements for some locations. The contractor is responsible for including the specific raceway requirements indicated in addition to those required of this and related specification sections.
- C. Provide conduit as indicated by related system device and/or equipment specification section to facilitate cable installation and as follows:
 - 1. Where cable is not allowed by applicable code to be routed in accessible ceiling spaces or in free-air.
 - 2. Where cable is allowed by applicable code to be routed in accessible ceiling spaces or in free-air.
 - a. From the Intermediate Distribution Frame, (IDF), Main Distribution Frame (MDF), or Equipment Room (ER) into accessible ceiling space.
 - b. From low voltage device outlet to an accessible ceiling space.
 - 1) For Voice and Data outlets:
 - (a) Provide minimum 1 inch conduit for CAT 6 cable, 1-1/4 inch conduit for CAT 6A cable, from outlet box to accessible ceiling. See drawings for additional requirements.
 - 2) For Audio/Visual outlets:
 - (a) See drawings.
 - 3) For Access Control, Intrusion Detection & Video Surveillance outlets:
 - (a) Provide minimum one 3/4 inch conduit from outlet box to accessible ceiling. See drawings for additional requirements.
 - 4) For Fire Alarm outlets:
 - (a) Provide minimum one 3/4 inch conduit from outlet box to accessible ceiling. See drawings for additional requirements.
 - 5) All other low-voltage device outlets:
 - (a) As indicated on the drawings.
 - 3. Where routing cable across inaccessible ceiling spaces longer than 10 feet:

- a. Provide sufficient quantity and sized conduit sleeves to not exceed 40% cable fill per conduit provided.

2.2 PATHWAYS

- A. Conduit: As specified in Section 260534.
- B. Surface Raceway: As specified in Section 260535.
- C. Boxes: As specified in Section 260537 and as specified herein.

2.3 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606.
- B. Comply with Section 260553.

2.4 ENCLOSURES/BACKBOARDS

- A. Backboards: Interior grade ACX or better plywood without voids, 3/4 inch thick; UL-labeled fire-retardant.
 1. Panel Size: 48 inches wide by 96 inches high. Provide minimum of one panel or quantity as necessary to accomplish coverage shown on drawings.
 2. Do not paint over UL label.
 3. Provide ground bus bar and #6 AWG insulated CU ground conductor to service ground, as specified in Section 260526.

2.5 DEVICE OUTLET BOXES

- A. Unless otherwise specified in related device's system section; flush mount outlet box depth shall be as required to accommodate cable manufacturer's recommended minimum conductor bend radius.
 1. Size, Unless Otherwise Indicated: 4 inches square by 2-1/8 inches deep.
 2. Wall-Mounted Telephones: 4 inches high by 2 inches wide by 2-1/8 inches deep.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- A. Firestopping: Seal openings around pathway penetrations through fire-related walls, partitions, floors, and ceilings in accordance with Section 078400.

3.2 INSTALLATION OF PATHWAYS

- A. Underground: Install conduit at least 24 inches below finish grade.
- B. Install with minimum clearances per Section 260534.
- C. In addition to as specified in Section 260534, provide pull string in all conduits where there is available conduit fill capacity for future cable installation.

3.3 INSTALLATION OF DEVICE OUTLET BOXES

- A. Install per Section 260537.
- B. Mounting heights: Unless otherwise indicated, as follows:
 - 1. Voice and Data Outlets: 18 inches above finished floor.
 - 2. Voice and Data Outlets for Forward and Side-Reach Wall-Mounted: 45 inches above finished floor.
- C. Orient outlet boxes for vertical installation of devices unless otherwise indicated.

END OF SECTION

STRUCTURED CABLING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Communications pathways.
- B. Copper cable and terminations.
- C. Fiber optic cable and interconnecting devices.
- D. Communications equipment room fittings.
- E. Communications outlets.
- F. Communications grounding and bonding.
- G. Communications identification.

1.2 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 260001 - Basic Electrical Materials and Methods.
- C. Section 260526 - Grounding and Bonding for Electrical Systems.
 - 1. Includes intersystem bonding termination.
 - 2. Includes bonding jumpers for bonding of communications systems and electrical system grounding.
- D. Section 260537 - Boxes for Electrical Systems.
- E. Section 260553 - Identification for Electrical Systems: Identification products.
- F. Section 262726 - Wiring Devices.
- G. Section 270528 - Pathways for Low-Voltage Systems Cabling
- H. Section 270529 - Hangers and Supports for Communications Systems.

1.3 REFERENCE STANDARDS

- A. ANSI- American National Standards Institute; Current Edition, Including All Revisions.
- B. BICSI N1- Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition; 2019.
- C. EIA/ECA-310- Cabinets, Racks, Panels, and Associated Equipment; 2005e.
- D. FM (AG)- FM Approval Guide; Current Edition.

- E. ICEA S-83-596- Indoor Optical Fiber Cable; 2021.
- F. ICEA S-102-700- Category 6 Individually Unshielded Twisted Pairs, Indoor Cables (With or Without an Overall Shield) for Use in General Purpose and LAN Communication Wiring Systems; 2021.
- G. NFPA 70- National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. TIA-455-21- Mating Durability of Fiber Optic Interconnecting Devices; 1988a (Reaffirmed 2012).
- I. TIA-492AAAC- Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers.
- J. TIA-492AAAC- Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak.
- K. TIA-526-7- Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 Edition 2: Fibre-Optic Communications Subsystem Test Procedures – Part 4-2: Installed Cable Plant – Single-Mode Attenuation and Optical Return Loss Measurement; 2015a (Reaffirmed 2022).
- L. TIA-568 (SET)- Commercial Building Telecommunications Cabling Standard Set; 2020.
- M. TIA-568.2-E- Balanced Twisted-Pair Telecommunications Cabling and Components Standards; 2018d, with Addenda (2020).
- N. TIA-568.3-E- Optical Fiber Cabling and Components Standard; 2022e.
- O. TIA-569-E-1- Telecommunications Pathways and Spaces; 2019e, with Addendum (2022).
- P. TIA-598 -D- Optical Fiber Cable Color Coding; 2014d, with Addendum (2024).
- Q. TIA-606-D- Administration Standard for Telecommunications Infrastructure; 2021d.
- R. TIA-607-E- Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2019d, with Addendum (2024).
- S. ANSI/TIA/EIA-568-E- Including All Revisions.
- T. UL (DIR)- Online Certifications Directory; Current Edition.
- U. UL 444- Communications Cables; Current Edition, Including All Revisions.
- V. UL 1651- Fiber Optic Cable; Current Edition, Including All Revisions.
- W. UL 1863- Communications-Circuit Accessories; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:

1. Coordinate requirements for service entrance and entrance facilities with Communications Service Provider.
 2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
 3. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Arrange for Communications Service Provider to provide service.
- C. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Communications Service Provider representative.

1.5 SUBMITTALS

- A. See Section 013300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- C. Sustainable Design Documentation: Submit manufacturer's product data on cable and cable insulation showing compliance with specified lead content requirements.
- D. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding.
- E. Evidence of qualifications for installer.
- F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
- G. Test Plan: Complete and detailed plan, with list of test equipment, procedures for inspection and testing, and intended test date; submit at least 60 days prior to intended test date.
- H. Field Test Reports.
- I. Project Record Documents:
1. Record actual locations of outlet boxes and distribution frames.
 2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
 3. Identify distribution frames and equipment rooms by room number on drawings.
- J. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of project record documents.

1.6 QUALITY ASSURANCE

- A. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- B. Manufacturer Qualifications: At least 3 years experience manufacturing products of the type specified.
- C. Installer Qualifications: A company having at least 3 years experience in the installation and testing of the type of system specified, and:
 - 1. Supervisors and installers factory certified by manufacturers of products to be installed.
- D. Products: Listed, classified, and labeled as suitable for the purpose intended.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation. In addition, cable must be stored in a location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 40 degrees Fahrenheit, the cable to be moved to a heated (50 degrees Fahrenheit minimum) location.
- B. Keep stored products clean and dry. If necessary, cable to be stored off site at the Contractor's expense.

1.8 WARRANTY

- A. See Section 017700 - Closeout Procedures, for additional warranty requirements.
- B. The Contractor shall provide a system warranty covering the installed cabling system against defects in workmanship, components, and performance, and follow-on support after project completion.
- C. The Contractor shall warrant the cabling system against defects in workmanship for a period of one year from the date of system acceptance. The warranty shall cover all labor and materials necessary to correct a failed portion of the system and to demonstrate performance within the original installation specifications after repairs are accomplished. This warranty shall be provided at no additional cost to the Owner.
- D. The Contractor shall facilitate a minimum 20-year system performance warranty between the manufacturer and the Owner. An extended component warranty shall be provided which warrants functionality of all components used in the system for a minimum of 20 years from the date of acceptance. The performance warranty shall warrant the installed 250 MHz horizontal copper of the cabling system. Copper links shall be warranted against the link performance minimum expected results defined in ANSI/TIA-568.2-E (latest draft). Fiber

optic links shall be warranted against the link and segment performance minimum expected results defined in ANSI/TIA-568.3-E (latest draft).

- E. The Contractor shall furnish an hourly rate with the proposal submittal which shall be valid for a period of one year from the date of acceptance. This rate will be used when cabling support is required to affect moves, adds, and changes to the system (MACs). MACs shall not void the Contractor's nor manufacturer's warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. These specifications use a single manufacturer's name, model, or catalog number herein for the purpose of establishing a product set. An equivalent for the specified product set may be used upon approval by the architect or engineer of record.
- B. Approved Manufacturers:
 - 1. Commscope Systimax: www.commscope.com/systimax.
 - 2. Leviton: www.leviton.com.
 - 3. Panduit/General Cable: www.pangensolutions.com.
 - 4. Hubbell/Draka Comteq: www.hubbell-premise.com; www.drakacomteq.us.

2.2 SYSTEM DESIGN

- A. Provide a complete permanent system of cabling and pathways for voice and data communications, including conduits and wireways, pull wires, support structures, enclosures and cabinets, rough-in boxes, conduit sleeves, and terminators.
 - 1. Comply with ANSI/TIA-568 and ANSI/TIA-569, latest editions.
 - 2. Comply with TIA-570, latest edition.
 - 3. Provide fixed cables and pathways that comply with NFPA 70 and ANSI/TIA-607 and are UL listed.
 - 4. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees Fahrenheit at relative humidity of 0 to 95 percent, noncondensing.
 - 5. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.
 - 6. Capacity: As required to terminate all cables plus minimum 25 percent spare space.

2.3 PATHWAYS

- A. Conduit: See section 270528 - Pathways for Low Voltage Systems Cabling.

2.4 COPPER CABLE AND TERMINATIONS

- A. Copper Horizontal Cable:
 - 1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568.2 and listed and labeled as complying with UL 444.
 - 2. Cable Type - Voice and Data: TIA-568.2 Category 6A UTP (unshielded twisted pair); 23 AWG.
 - 3. Cable Capacity: 4-pair.

4. Cable Applications: Use listed NFPA 70 Type CMP plenum cable unless otherwise indicated.
 5. Cable Applications:
 - a. Plenum Applications: Use listed NFPA 70 Type CMP plenum cable.
 - b. Riser Applications: Use listed NFPA 70 Type CMR riser cable or Type CMP plenum cable.
 - c. General Purpose Applications: Use listed NFPA 70 Type CM/CMG general purpose cable, Type CMR riser cable, or Type CMP plenum cable.
 6. Product(s):
 - a. CommScope; SYSTIMAX Twisted Pair Cables; GigaSPEED XL Category 6A U/UTP Cable: www.commscope.com/#sle.
 - 1) Riser Rated: Systimax p/n 1091B BLU C6A 4/23 U/UTP.
 - 2) Plenum Rated: Systimax p/n 2091B BLU C6A 4/23 U/UTP.
- B. Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.
- C. Jacks and Connectors: Modular RJ-45, non-keyed, terminated with 110-style insulation displacement connectors (IDC); high impact thermoplastic housing; suitable for and complying with same standard as specified horizontal cable; UL 1863 listed.
1. As specified under COMMUNICATIONS OUTLETS.
- D. Copper Patch Cords:
1. Description: Factory-fabricated 4-pair cable assemblies with 8-position modular connectors terminated at each end.
 2. Patch Cords for Patch Panels:
 - a. Quantity: One for each pair of patch panel ports.
 - b. Length: 7 feet.
 3. Patch Cords for Work Areas:
 - a. Quantity: One for each work area outlet port.
 - b. Length: 10 feet.
 4. Product(s):
 - a. CommScope; SYSTIMAX Category 6A U/UTP Patch Cords: www.commscope.com/#sle.

2.5 FIBER OPTIC CABLE AND INTERCONNECTING DEVICES

- A. Fiber Optic Backbone Cable:
1. Description: Single Armor, gel free, stranded loose tube, non-conductive fiber optic cable complying with ANSI/TIA-568.3, ANSI/TIA-598, ICEA S-87-640 and listed as complying with UL 444 and UL 1651.
 2. Cable Type: Singlemode, laser-optimized, 250um (OS2).
 3. Cable Capacity: Quantity of fibers as indicated on drawings.
 4. Cable Jacket Color:
 - a. Black.
 - b. Single-Mode Fiber (OS2): Black.
 5. Outer Sheath: The outer sheath shall be marked with the manufacturer's name, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet.
 6. Product(s):

- a. 6-Strand Fiber Optic Cables; TeraSpeed Zero Water Peak Single-Mode Fiber #D-006-LA-8W-F06RD/HD.: www.commscope.com/#sle.
 - b. 12-Strand Fiber Optic Cables; TeraSpeed Zero Water Peak Single-Mode Fiber #D-012-LA-8W-F12NS: www.commscope.com.
- B. Fiber Optic Interconnecting Devices:
 - 1. Connector Type: Type LC.
 - 2. Connector Performance: 500 mating cycles.
 - 3. Maximum Attenuation/Insertion Loss: 0.3 dB.
 - 4. Product(s):
 - a. CommScope Fiber Optic Connectors; QWIK II-LC Fiber Connectors: www.commscope.com/#sle.
- C. Fiber Optic Patch Cords:
 - 1. Description: Factory-fabricated 2-fiber cable assemblies with suitable connectors at each end.
 - 2. Patch Cords for Patch Panels:
 - a. Quantity: One for each pair of patch panel ports.
 - b. Length: 10 feet.
 - 3. Product(s):
 - a. CommScope Fiber Optic Patch Cords; TeraSpeed Fiber Patch Cords: www.commscope.com/#sle.

2.6 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

- A. Copper Cross-Connection Equipment:
 - 1. Manufacturers:
 - a. CommScope: www.commscope.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
 - 2. Connector Blocks for Category 6A Cabling: Type 110 insulation displacement connectors; capacity sufficient for cables to be terminated plus 25 percent spare.
 - 3. Patch Panels for Copper Cabling: Sized to fit EIA/ECA-310 standard 19 inch wide equipment racks; angled type; 0.09 inch thick aluminum; cabling terminated on Type 110 insulation displacement connectors; printed circuit board interface.
 - a. Jacks: Non-keyed RJ-45, suitable for and complying with same standard as cable to be terminated; maximum 48 ports per standard width panel.
 - b. Capacity: Provide ports sufficient for cables to be terminated plus 25 percent spare.
 - c. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
 - d. Provide incoming cable strain relief and routing guides on back of panel.
 - 4. Product(s):
 - a. CommScope; SYSTIMAX Copper Panels; 360-iP-1100A-E-GS6 Series Patch Panels: www.commscope.com/#sle.
 - 5. Building Entrance Protection:
 - a. Copper backbone cables routed from building exterior shall be terminated on over-voltage protection blocks immediately upon entering the building to protect telecommunication equipment from transients. Protector blocks shall utilize 110 style connectors on both the input and output side. Protectors shall be solid state type.

B. Fiber Optic Cross-Connection Equipment:

1. Manufacturers:
 - a. CommScope: www.commscope.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
2. Patch Panels for Fiber Optic Cabling: Sized to fit EIA/ECA-310 standard 19 inch wide equipment racks; 0.09 inch thick aluminum.
 - a. Adapters: As specified above under FIBER OPTIC CABLE AND INTERCONNECTING DEVICES; maximum of 24 duplex adaptors per standard panel width.
 - b. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
 - c. Provide incoming cable strain relief and routing guides on back of panel.
 - d. Provide rear cable management tray at least 8 inches deep with removable cover.
 - e. Provide dust covers for unused adapters.
3. Product(s):
 - a. Fiber Patch Panel CommScope; EPX Series: www.commscope.com/#sle.
 - b. Adapter Packs: CommScope LGX/1000, or approved equal: www.commscope.com.

C. Equipment Frames, Racks and Cabinets:

1. Floor Mounted Racks: Aluminum or steel construction with corrosion resistant finish; vertical and horizontal cable management channels, top and bottom, cable troughs, and grounding lug.
 - a. The rack shall conform to the following requirements:
 - 1) Rack shall be 84" in height and shall be self-supporting.
 - 2) Channel uprights shall be spaced to accommodate Industry Standard 19" mounting.
 - 3) Rack must be constructed of aluminum and shall have a black coating or painted surface.
 - 4) Rack shall be double side drilled and tapped to accept 12-24 screws. Uprights shall also be drilled on back to accept cable brackets, clamps, power strip(s), etc. Hole pattern on front and rear of rack shall be per EIA/TIA specifications (5/8"-5/8"-1/2").
 - 5) Rack should be supplied with a supply of spare screws (minimum of 24).
 - 6) Base footprint should be no smaller than 15"x20".
 - 7) Load rating of 1500 lbs.
 - 8) Rack shall be placed at least 3' from the wall at the base of the rear mounting plate unless room does not allow or prior authorization by District Project Coordinator.
 - (a) Product(s):

(1) Chatsworth; p/n 46053-703.

- D. Cable Management: Rack shall be equipped with vertical wire management hardware in the form of finger ducts as to allow an orderly routing of twisted pair, optical fiber and coaxial jumpers from the patch panels to the customer provided network equipment. It is the District's intent to manage horizontal patch cords utilizing angles, patch panels, and high-density vertical wire management to eliminate the requirement for horizontal wire management in equipment racks. There will still be a requirement for horizontal wire managers in cabinets or

other areas where space prohibits the use of the angled patch panels. Patch cable wire management hardware shall be as follows:

1. Floor Mounted Racks:
 - a. Vertical Wire Managers shall be Combination Cabling Section, CPI p/n 30162-703. Vertical jumper management shall provide for cable routing on front and rear of each rack and be 6" wide channel (minimum). Vertical jumper management hardware shall mount to the rack uprights and not on the upright itself. Where multiple racks are to be installed, this hardware shall be mounted between the uprights of adjacent racks. If the rack adjacent to the vertical wire manager on either side will house/terminate more than 350 cables, then a 10" vertical wire manager, CPI p/n 30163-703 shall be used.
 - b. Minimum of twelve (12) releasable (e.g. "hook & loop") cable support ties on the rear and finger duct style wire management on the front.
 - c. Horizontal Wire Managers shall be CPI p/n 30130-719, when required.
 - 1) Horizontal jumper management panels shall be molded plastic (3.5" panel) and utilize "finger duct" style entry/exit. They shall incorporate a double-hinged cover.
 - 2) At minimum, horizontal cable management hardware shall be positioned above and below each grouping of two rows of jack data patch panels and (b) above and below each fiber optic patch panel.
 - d. Rack Radius Drops shall be CPI p/n 12394-701.
 - 1) Rack radius drops shall be used on ALL equipment racks to provide a transition from an above rack horizontal cable run to the vertical cabling section to maintain proper cabling bend radius.
 - e. Rear Cable Support Bars shall be CommScope p/n 406042-1 or equivalent.
 - 1) Contractor to install rear cable support bars to provide additional cable support and routing control in the rear of the equipment racks. Other manufacturers cable support bars are acceptable.

2.7 LADDER RACKS

- A. Manufacturer: Chatsworth Products, Inc.; Model 10250-718 (18" wide racks): www.chatsworth.com.
- B. Tubular steel bar type cable racks with 0.065" thick side rails. 1.5" high x 0.375" wide stringers. 1.5" wide x 0.375" high rung set 12" on center. Widths as notes.
- C. Complete with all necessary supports, hangars, connectors, nuts, bolts, etc., necessary for a complete installation.
- D. Ladder racks shall be supported a minimum of every 5 feet on center and at the end of every ladder rack run, utilizing trapeze type supports (as recommended by the manufacturer), attached directly to the structure above. Provide wall angle support kits where ladder rack terminates at wall.
- E. Provide end-closing kits on all ladder rack ends.
- F. Ladder racks shall be installed at 7'0" AFF to underside of ladder, unless otherwise noted.
- G. Coordinate placement of ladder racks and supports with duct work, conduits, piping, and lighting fixtures.

2.8 COMMUNICATIONS OUTLETS

- A. Faceplates:
 - 1. 4 port angled faceplate constructed of ABS molding compound. Each port shall be provided with an icon to indicate its function. Faceplate shall accommodate two labels and provide a clear polycarbonate cover for each. All unused port positions shall have a blank insert installed. Faceplate ports shall be populated left to right, top to bottom.
 - 2. Color: White.
 - 3. CAT 6A.
 - 4. Manufacturer: CommScope p/n M14AS-262.
- B. Modular Jacks
 - 1. All modular jacks shall be wired to the T568B wiring pattern. Modular jacks shall be constructed with a housing of polyphenylene oxide, 94V-0 rated. Modular jacks shall be terminated using a 110-style pc board connector (made of 94V-0 rated polycarbonate), color-coded for both T568B wiring. The 110 connector shall terminate 22-24 AWG solid conductors with a maximum insulation diameter of 0.5 inch. The modular jack contacts shall be plated with a minimum of 50 micro inches of gold in the contact area over a 50 micro inch minimum nickel underplate. Modular jacks shall be UL Listed.
 - 2. Color: As selected by Owner.
 - 3. CAT 6A Manufacturer: CommScope p/n MGS600-BL.
 - a. Color: Blue.
- C. Standard Configurations:
 - 1. Unless otherwise noted, each voice / data outlet location shall be provided with 2 Category 6A UTP cables terminated on Category 6A modular RJ-45 jacks.
 - 2. Wireless Access Point:
 - a. Located at accessible ceilings: Provide 2 - Category 6A UTP cable terminated on Category 6A modular RJ-45 jacks.
 - b. Located at inaccessible ceilings or shown on wall: Provide outlet junction box with 2- Category 6A modular jack and faceplate capable of supporting up to two jacks.
 - 3. Projector or Large Format Display (LFD) Outlet:
 - a. 2 - Category 6A UTP cable terminated on Category 6A modular RJ-45 jacks. See drawings for outlet box information.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- A. Comply with latest editions and addenda of ANSI/TIA-568 (SET)(cabling), ANSI/TIA-569 (pathways), ANSI/TIA-607 (grounding and bonding), BICSI N1, NFPA 70, and SYSTEM DESIGN as specified in PART 2.
- B. Comply with latest editions and addenda of ANSI/TIA-570, ANSI/ TIA-607, NFPA 70, and SYSTEM DESIGN as specified in PART 2.
- C. Comply with Communication Service Provider requirements.
- D. Grounding and Bonding: Perform in accordance with ANSI/TIA-607 and NFPA 70.

- E. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

3.2 INSTALLATION OF EQUIPMENT AND CABLING

- A. Cabling:
 - 1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
 - 2. Do not over-cinch or crush cables.
 - 3. Do not exceed manufacturer's recommended cable pull tension.
 - 4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
- B. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
 - 1. At Distribution Frames: 120 inches.
 - 2. At Outlets - Copper: 12 inches.
- C. Copper Cabling:
 - 1. Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
 - 2. For 4-pair cables in conduit, do not exceed 25 pounds pull tension.
 - 3. Use T568B wiring configuration.
 - 4. Field terminated copper patch cords not allowed.
 - 5. Horizontal cables shall not exceed a total installed length of 295-feet.
 - 6. No splices in horizontal cables permitted.
- D. Fiber Optic Cabling:
 - 1. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
 - 2. Support vertical cable at intervals as recommended by manufacturer.
- E. Floor-Mounted Racks and Enclosures: Permanently anchor to floor in accordance with manufacturer's recommendations.
- F. Identification:
 - 1. Use wire and cable markers to identify cables at each end.
 - 2. Use manufacturer-furnished label inserts, identification labels, or engraved wallplate to identify each jack at communications outlets with unique identifier.
 - 3. Use identification nameplate to identify cross-connection equipment, equipment racks, and cabinets.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Comply with inspection and testing requirements of specified installation standards.
- C. Visual Inspection:
 - 1. Inspect cable jackets for certification markings.
 - 2. Inspect cable terminations for color coded labels of proper type.
 - 3. Inspect outlet plates and patch panels for complete labels.

4. Inspect patch cords for complete labels.
- D. Testing - Copper Cabling and Associated Equipment:
1. Test each complete copper horizontal station cabling system in accordance with ANSI/TIA-568-C.2 standards. The minimum level of instrument accuracy for field testing of CAT6 cabling is a Level III or higher tester. Test should be performed using a Fluke DSP-5000 or equivalent tester, which means the Level III tester standard. The acceptance standard for these items is 100 percent fully meeting standards.
 2. Provide electronic copy of test reports (saved in PDF format to USB or other non-volatile storage media accessible by a Windows PC).
- E. Testing - Fiber Optic Cabling:
1. Testing of all fiber optic cabling infrastructure must be performed in accordance with the following:
 - a. ANSI/TIA/EIA-568-C-0 - Commercial Building Telecommunications Cabling Standard: General Requirements.
 - b. ANSI/TIA/EIA-568-E - Optical Fiber Cabling Components Standard.
 2. Minimum testing for all fiber optic cables requires the use of an optical power meter and optical power source equivalent to Fluke DSP-5000. OTDR records must be provided as well for all fiber optic installations.
 3. Total attenuation (dB loss) in each optical single-mode fiber, bi-directionally, including the connector on each end, for both the 1300 and 1550 nm (nanometer) range must be recorded in the test documentation.
 4. Transmit and receive polarity must be recorded in the electronic test documentation.
 5. End-to-end attenuation of each individual optical fiber, including LC connectors housed in appropriate bulkheads, shall not exceed the following:
 - a. An additional .75db per mated pair and .3db per splice is allowed.
 - b. .5db/Km at 1310nm or 1550nm for outside plant single mode cable.
 6. Return and propagation loss for each direction for each strand shall be averaged and reported at 850nm and 1300nm for multi-mode and 1310nm and 1500nm for single mode. Each strand shall be OTDR'd with a current OTDR testing device. Optical length or any anomalies shall be reported.
 7. Jacket foot markings shall be reported for all fiber ends. Any runs failing to meet the standards must be identified by the Contractor, and removed and replaced with runs that prove, in testing, to meet the standards.
 8. Loop-back testing which uses a jumper to test two (2) or more individual optical fibers together will not be allowed.
 9. Provide electronic (saved in PDF format to USB or other non-volatile storage media accessible by a Windows PC) test reports.
- F. Final Testing: After all work is complete, including installation of telecommunications outlets, and telephone dial tone service is active, test each voice jack for dial tone.

END OF SECTION

FIRE DETECTION AND ALARM

PART 1 GENERAL

1.1 DESCRIPTION

- A. Use this specification and drawings as a guide for workmanship and materials for construction. Utilize the design/build concept throughout the design and construction phase of the project.
- B. Visit the site of proposed construction prior to starting the design. Verify and inspect the existing site to determine conditions that affect this work.

1.2 SECTION INCLUDES

- A. Fire alarm system design and installation, including all components, wiring, and conduit.
- B. Transmitters for communication with supervising station.
- C. Circuits from protected premises to supervising station, including conduit.
- D. Replacement and removal of existing fire alarm system components, wiring, and conduit indicated.
- E. Maintenance of fire alarm system under contract for specified warranty period.

1.3 RELATED REQUIREMENTS

- A. Section 087100 - Door Hardware: Electrically operated locks and door holder devices to be monitored and released by fire alarm system.
- B. Section 142100 - Electric Traction Elevators: Elevator systems monitored and controlled by fire alarm system.
- C. Section 211300 - Fire-Suppression Sprinkler Systems: Supervisory, alarm, and actuating devices installed in sprinkler system.
- D. Section 233300 - Air Duct Accessories: Smoke dampers monitored and controlled by fire alarm system.
- E. Section 260001 - Basic Electrical Materials and Methods.

1.4 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
- B. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.

- C. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits; 2025.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. NFPA 72 - National Fire Alarm and Signaling Code; Most Recent Edition Cited by Referring Code or Reference Standard.
- F. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 864 - Control Units and Accessories for Fire Alarm Systems; Current Edition, Including All Revisions.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Proposal Documents: Submit the following with cost/time proposal:
 - 1. NFPA 72 "Record of Completion", filled out to the extent known at the time.
 - 2. Manufacturer's detailed data sheet for each control unit, initiating device, and notification appliance.
 - 3. Certification by Contractor that the system design will comply with Contract Documents.
 - 4. Proposed maintenance contract.
- C. Drawings must be prepared using AutoCAD Release 2014.
 - 1. Owner will provide floor plan drawings for Contractor's use; verify all dimensions on Owner-provided drawings.
- D. Evidence of designer qualifications.
- E. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
 - 1. Copy (if any) of list of data required by authority having jurisdiction.
 - 2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
 - 3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
 - 4. System zone boundaries and interfaces to fire safety systems.
 - 5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
 - 6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
 - 7. List of all devices on each signaling line circuit, with spare capacity indicated.
 - 8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
 - 9. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.

10. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
 11. Certification by Contractor that the system design complies with Contract Documents.
 12. Do not show existing components to be removed.
 13. Shop drawings will need to be stamped by a NICET Level III certified fire alarm technician.
- F. Evidence of installer qualifications.
- G. Evidence of instructor qualifications; training lesson plan outline.
- H. Evidence of maintenance contractor qualifications, if different from installer.
- I. Inspection and Test Reports:
1. Submit inspection and test plan prior to closeout demonstration.
 2. Submit documentation of satisfactory inspections and tests.
 3. Submit NFPA 72 "Inspection and Test Form," filled out.
- J. Operating and Maintenance Data: See Section 017800 - for additional requirements; have one set available during closeout demonstration:
1. Complete set of specified design documents, as approved by authority having jurisdiction.
 2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
 3. Contact information for firm that will be providing contract maintenance and trouble call-back service.
 4. List of recommended spare parts, tools, and instruments for testing.
 5. Replacement parts list with current prices, and source of supply.
 6. Detailed troubleshooting guide and large scale input/output matrix.
 7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
 8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.
- K. Project Record Documents: See Section 017800 - for additional requirements, have one set available during closeout demonstration:
1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
 2. "As installed" wiring and schematic diagrams, with final terminal identifications.
 3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.
- L. Closeout Documents:
1. Certification by manufacturer that the system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.
 2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
 3. Certificate of Occupancy.
 4. Maintenance contract.

5. Written warranty.
 6. Report on training results.
- M. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
1. See Section 016000 - Product Requirements, for additional provisions.
 2. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.
 3. In addition to the items in quantities indicated in PART 2, furnish the following:
 - a. All tools, software, and documentation necessary to modify the fire alarm system using Owner's personnel; minimum modification capability to include addition and deletion of devices, circuits, and zones, and changes to system description, operation, and evacuation and instructional messages.
 - b. Two copies, on CD-ROM, of all software not resident in read-only-memory.
 - c. Extra Fuses: Two for each installed fuse; store inside applicable control cabinet.

1.6 QUALITY ASSURANCE

- A. Copies of Design Criteria Documents: Maintain at the project site for the duration of the project, bound together, an original copy of NFPA 72, the relevant portions of applicable codes, and instructions and guidelines of authorities having jurisdiction; deliver to Owner upon completion.
- B. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.
- C. Installer Qualifications: Firm with minimum 5 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
 2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
 3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
 4. Contract maintenance office located within 50 miles of project site.
 5. Certified in the State in which the Project is located as fire alarm installer.
- D. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.
- E. Each and all items of the Fire Alarm System shall be listed as a product of a SINGLE fire alarm system manufacturer under the appropriate category by Underwriters' Laboratories, Inc. (UL), and shall bear the "UL" label. All control equipment shall be listed under UL category UOJZ as a single control unit. Partial listing shall NOT be acceptable.

- F. All control equipment must have transient protection devices to comply with UL 864 requirements.
- G. In addition to the UL UOJZ requirement mentioned above, the system controls shall be UL listed for Power Limited Applications per NEC 760. All circuits must be marked in accordance with NEC article 760.23.

1.7 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after date of Substantial Completion.
- C. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Fire Alarm Control Units and Accessories - Basis of Design:
 - 1. Honeywell Security & Fire Solutions / Silent Knight: <https://buildings.honeywell.com/>
- B. Initiating Devices and Notification Appliances:
 - 1. None: Specified product is Owner standard.
- C. Substitutions: See Section 016000 - Product Requirements.
 - 1. For other acceptable manufacturers of control units specified, submit product data showing equivalent features and compliance with Contract Documents.
 - 2. For substitution of products by manufacturers not listed, submit product data showing features and certification by Contractor that the design will comply with Contract Documents.

2.2 FIRE ALARM SYSTEM

- A. Fire Alarm System: Replace existing automatic fire detection and alarm system:
 - 1. Provide all components necessary, regardless of whether shown in Contract Documents or not, for a complete and operable system.
 - 2. Protected Premises: Entire building shown on drawings.
 - 3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
 - a. ADA Standards.
 - b. The requirements of the State Fire Marshal.
 - c. The requirements of the local authority having jurisdiction .
 - d. Applicable local codes.
 - e. Contract Documents (drawings and specifications).
 - f. NFPA 101.

- g. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
 - 4. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
 - 5. Voice Notification: Provide emergency voice/alarm communications with multichannel capability; digital.
 - 6. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.
 - 7. Program notification zones and voice messages as directed by Owner.
 - 8. Hearing Impaired Occupants: Provide visible notification devices in all public areas and in dwelling units.
 - 9. Fire Command Center: Location indicated on drawings.
 - 10. Master Fire Alarm Control Unit (Panel): New, location indicated on drawings.
 - 11. Combined Systems: Do not combine fire alarm system with other non-fire systems.
- B. Supervising Stations and Fire Department Connections:
- 1. Public Fire Department Notification: By on-premises supervising station.
 - 2. Remote Supervising Station: UL-listed central station under contract to facility.
 - 3. Means of Transmission to Remote Supervising Station: IP based communicator or cellular wireless transmitter Confirm acceptable methods with AHJ.
- C. Circuits:
- 1. Initiating Device Circuits (IDC): Class B, Style A.
 - 2. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 4.
 - 3. Signaling Line Circuits (SLC) Between Buildings: Class A, Style 6.
 - 4. Notification Appliance Circuits (NAC) Within Single Building: Class B, Style Y.
 - 5. Notification Appliance Circuits (NAC) Between Buildings: Class A, Style Z.
- D. Spare Capacity:
- 1. Initiating Device Circuits: Minimum 25 percent spare capacity.
 - 2. Notification Appliance Circuits: Minimum 25 percent spare capacity.
 - 3. Speaker Amplifiers: Minimum 25 percent spare capacity.
 - 4. Master Fire Alarm Control Unit: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.
- E. Power Sources:
- 1. Primary: Dedicated branch circuits of the facility power distribution system.
 - 2. Secondary: Storage batteries.
 - 3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.
 - 4. Each Computer System: Provide uninterruptible power supply (UPS).

2.3 EXISTING COMPONENTS

- A. Existing Fire Alarm System: Remove existing system completely after new system is fully operational and tested.
- B. Clearly label components that are "Not In Service."

- C. Remove unused existing components and materials from site and dispose of properly.

2.4 FIRE SAFETY SYSTEMS INTERFACES

- A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
 - 1. Sprinkler water control valves.
 - 2. Dry-pipe sprinkler system pressure.
 - 3. Dry-pipe sprinkler valve room low temperature.
 - 4. Sprinkler water storage tank low level.
 - 5. Sprinkler water storage tank low temperature.
- B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
 - 1. Sprinkler water flow.
 - 2. Total flooding suppression system activation.
 - 3. Kitchen hood suppression activation; also disconnect fuel source from cooking equipment.
 - 4. Duct smoke detectors.
- C. HVAC:
 - 1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers indicated.
- D. Doors:
 - 1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor.
 - 2. Electromagnetic Door Locks on Egress Doors: Unlock upon activation of any alarm initiating device or suppression system in smoke zone that doors serve as egress from.

2.5 COMPONENTS

- A. General:
 - 1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
 - 2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.
- B. Fire Alarm Control Units, Initiating Devices, and Notification Appliances: Analog, addressable type; listed, classified, and labeled by Underwriters Laboratories as suitable for the purpose intended.
- C. Master Control Unit: As specified for Basis of Design above, or equivalent.
 - 1. Construction shall be modular with solid state, microprocessor based electronics. An 80 character LCD display shall indicate alarms, supervisory service conditions, and any troubles. Panel shall have 250 addressable points with internal dialer.
 - 2. Expansion Power Supplies: Provide as required for notification appliance circuits. Power supply to provide 8 Amps of power, four signal circuits, and battery standby.
 - a. Silent Knight 6820EVS Series.
- D. Remote Annunciators: Shall be 80 character LCD display and include four programmable control switches, as well as alarm silence, acknowledgment, and system reset switches.
 - 1. Silent Knight 6855 Series.

2. Notifier Series or approved.
- E. Cellular Communicator: LTE Universal Wireless Fire Alarm Communicator. Full Event Reporting, 5G-LTE-M, 4 on board inputs/outputs, UL 864 listed.
1. Include setup, programming, assist owner with establishing cellular plan/contract and monitoring.
 2. Provide extension antenna as necessary.
 3. Include power supply/battery backup as required by code.
- F. Initiating Devices:
1. Manual Pull Stations: Manual Pull Stations: Shall be addressable, single or double action, and constructed of high impact, red lexan with raised white lettering and a smooth high gloss finish. Stations which utilize screwdrivers, allen wrenches, or other commonly available tools shall not be accepted. Stations shall be keyed alike with the fire alarm control panel. When the station is operated, the handle shall lock in a protruding manner to facilitate quick visual identification of the activated station.
 - a. SK-Pull Series or approved.
 - b. Provide 1 extra.
 2. Smoke Detectors: Smoke Detectors: Photo electric smoke detectors. Each smoke detector shall have its own unique address, analog, and with selectable sensitivity. Detectors shall be listed to UL standard 268 and shall be documented compatible with the control equipment to which it is connected. Detectors shall be listed for this purpose by Underwriters Laboratories Inc. The detectors shall obtain their operating power from the fire alarm panel supervised detection loop. The operating voltage shall be 24VDC (nominal). Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal to be generated at the control panel. Each detector shall have a flashing status indicating LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady and at full brilliance. The detector may be reset by actuating the control panel reset switch. Remote LED alarm indicators shall be installed where indicated.
 - a. SK-Photo Series or approved.
 - b. Provide 5 extra.
 3. Duct Smoke Detectors: Shall be addressable and of the solid state photoelectric type. The detectors shall operate on the light scattering photodiode principle. Detector design shall provide full solid state construction and compatibility with being separately monitored via a unique address via the twisted shielded pair data loop.
 - a. SK-Duct Series or approved.
 - b. Provide 1 extra.
 4. Heat Detectors: Heat Detectors: Automatic heat detectors shall be combination rate-of-rise and fixed-temperature type. Each heat detector shall have its own unique address.
 - a. SK-HEAE Series or approved.
 - b. Provide 1 extra.
 5. Addressable Interface Devices:
 - a. SK Series or approved.
 - b. Provide 3 extra.
- G. Notification Appliances:
1. Audible/visible units shall provide a common enclosure for fire alarm audible and visual alarm devices. Models shall be available which provide for horizontal or vertical mounting and with high humidity and strobe synchronization options. The audio/visual

combination unit shall provide 4 Wire connection to ensure properly supervised in/out system connection and shall be UL listed for its intended purpose. Device candela shall be rated per current NFPA and ADA requirements.

- a. L-Series or SpectAlert - Series or approved.
- b. Provide 3 extra audible/visible units.

- H. Circuit Conductors: Copper or optical fiber; provide 200 feet extra; color code and label.
- I. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.
 1. Equipment Connected to Alternating Current Circuits: Maximum let through voltage of 350 V(ac), line-to-neutral, and 350 V(ac), line-to-line; do not use fuses.
 2. Initiating Device Circuits, Notification Appliance Circuits, and Communications Circuits: Provide surge protection at each point where circuit exits or enters a building; rated to protect applicable equipment; for 24 V(dc) maximum dc clamping voltage of 36 V(dc), line-to-ground, and 72 V(dc), line-to-line.
 3. Signaling Line Circuits: Provide surge protection at each point where circuit exits or enters a building, rated to protect applicable equipment.
- J. Locks and Keys: Deliver keys to Owner.
 1. Provide the same standard lock and key for each key operated switch and lockable panel and cabinet; provide 5 keys of each type
- K. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
 1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
 2. Provide one for each control unit where operations are to be performed.
 3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
 4. Provide extra copy with operation and maintenance data submittal.
- L. Storage Cabinet for Spare Parts and Tools: Steel with baked enamel finish, size appropriate to quantity of parts and tools.
 1. Padlock eye and hasp for lock furnished by Owner.
 2. Locate as directed by Owner.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install the system in accordance with the plans and specifications all applicable codes, NFPA 72, NFPA 70, Contract Documents, and the manufacturer's recommendations. All wiring shall be installed in strict compliance with all the provisions of NEC - Article 760 A and C, Power-Limited Fire Protective Signaling Circuits or if required may be reclassified as non-power limited and wired in accordance with NEC-Article 760 A and B. Upon completion, the contractor shall so certify in writing to the owner and general contractor. All junction boxes shall be sprayed red and labeled "Fire Alarm". Wiring color code shall be maintained throughout the installation.
- B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.

- C. Obtain Owner's approval of locations of devices, before installation.
- D. Install instruction cards and labels.
- E. Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate subcontractors.
- F. The contractor shall clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of the installation.
- G. The manufacturer's authorized representative shall provide on site supervision of installation.

3.2 INSPECTION AND TESTING FOR COMPLETION

- A. Notify Owner 7 days prior to beginning completion inspections and tests.
- B. Owner will provide the services of an independent fire alarm engineer or technician to observe all tests.
- C. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- D. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- E. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- F. Provide all tools, software, and supplies required to accomplish inspection and testing.
- G. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
- H. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
- I. Diagnostic Period: After successful completion of inspections and tests, Operate system in normal mode for at least 14 days without any system or equipment malfunctions.
 - 1. Record all system operations and malfunctions.
 - 2. If a malfunction occurs, start diagnostic period over after correction of malfunction.
 - 3. Owner will provide attendant operator personnel during diagnostic period; schedule training to allow Owner personnel to perform normal duties.
 - 4. At end of successful diagnostic period, fill out and submit NFPA 72 "Inspection and Testing Form."

3.3 OWNER PERSONNEL INSTRUCTION

- A. Provide the following instruction to designated Owner personnel:
 - 1. Hands-On Instruction: On-site, using operational system.
 - 2. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.
 - 3. Factory Instruction: At control unit manufacturer's training facility, as required

- B. Provide a total of 16 hours of initial/refreshers training to designated Owner personnel covering issues for the topics below. Duration of individual training sessions as determined by Owner, not to exceed total number of required hours.
- C. Administrative: Issues necessary for non-technical administrative staff.
- D. Basic / Detailed Operation: Issues necessary for attendant personnel, security officers, and engineering staff.
- E. Maintenance Technicians: Issues necessary for electrical technicians, on programming, maintaining, repairing, and modifying.
- F. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.
- G. Provide means of evaluation of trainees suitable to type of training given; report results to Owner.

3.4 CLOSEOUT

- A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
 - 1. Be prepared to conduct any of the required tests.
 - 2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
 - 3. Have authorized technical representative of control unit manufacturer present during demonstration.
 - 4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
 - 5. Repeat demonstration until successful.
- B. Occupancy of the project will not occur prior to Substantial Completion.
- C. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
 - 1. Specified diagnostic period without malfunction has been completed.
 - 2. Approved operating and maintenance data has been delivered.
 - 3. Spare parts, extra materials, and tools have been delivered.
 - 4. All aspects of operation have been demonstrated to Owner.
 - 5. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
 - 6. Occupancy permit has been granted.
 - 7. Specified pre-closeout instruction is complete.
- D. Perform post-occupancy instruction within 3 months after Substantial Completion.

3.5 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

- B. Provide to Owner, at no extra cost, a written maintenance contract for entire manufacturer's warranty period, to include the work described below.
- C. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
 - 1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
 - 2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
 - 3. Record keeping required by NFPA 72 and authorities having jurisdiction.
- D. Provide trouble call-back service upon notification by Owner:
 - 1. Provide on-site response within 2 hours of notification.
 - 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 - 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
- E. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
- F. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.
- G. Comply with Owner's requirements for access to facility and security.

END OF SECTION