

**SECTION 26 00 00**  
**BASIC ELECTRICAL MATERIALS AND METHODS**



**PART 1 GENERAL**

**1.1 REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

**AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)**

ASTM D709                      (2025) Laminated Thermosetting Material

**CODE OF FEDERAL REGULATIONS (CFR)**

29 CFR 1910.147              Control of Hazardous Energy (Lock Out/Tag Out)

**INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)**

IEEE C2                      (2023) National Electrical Safety Code

IEEE C57.12.28              (2023) Standard for Pad-Mounted Equipment - Enclosure Integrity

IEEE 100                      (2000; Archived) The Authoritative Dictionary of IEEE Standard Terms

**NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)**

NEMA 10250                  (2024) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA IA 10030              (2024) Industrial Control and Systems: Enclosures

**NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)**

NFPA 70                      (2020) National Electrical Code

**1.2 RELATED REQUIREMENTS**

This section applies to all sections of Division 26, "Electrical," and Division 27, "Communications," of this project specification unless specified otherwise in the individual sections.

**1.3 DEFINITIONS**

- A. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.
- B. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.
- C. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

**1.4 ELECTRICAL CHARACTERISTICS**

Electrical characteristics for this project shall be 120/240 volts, single phase, three wire, 60 Hz. Final connections to the power distribution system at the new service disconnect and at the pole mounted transformers shall be made by the Contractor as directed by the Design Professional.

## 1.5 SUBMITTALS

Submittals required in the sections which refer to this section shall conform to the requirements of the Submittals Section and to the following additional requirements. Submittals shall include the manufacturer's name, trade name, place of manufacture, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and technical paragraph reference. Submittals shall also include applicable federal, military, industry, and technical society publication references, and years of satisfactory service, and other information necessary to establish contract compliance of each item to be provided. Photographs of existing installations are unacceptable and will be returned without approval.

- A. **Manufacturer's Catalog Data:** Submittals for each manufactured item shall be current manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog cuts. Handwritten and typed modifications and other notations not part of the manufacturer's preprinted data will result in the rejection of the submittal. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified for certificates of compliance.
- B. **Drawings:** Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.
- C. **Instructions:** Where installation procedures or part of the installation procedures are required to be in accordance with manufacturer's instructions, submit printed copies of those instructions prior to installation. Installation of the item shall not proceed until manufacturer's instructions are received. Failure to submit manufacturer's instructions shall be cause for rejection of the equipment or material.
- D. **Certificates:** Submit manufacturer's certifications as required for products, materials, finishes, and equipment as specified in the technical sections. Certificates from material suppliers are not acceptable. Preprinted certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material." Certifications shall simply state that the item conforms to the requirements specified.

Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance.

- 1. **Reference Standard Compliance:** Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), Underwriters Laboratories Inc. (UL), and Association of Edison Illuminating Companies (AEIC), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.
  - 2. **Independent Testing Organization Certificate:** In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Design Professional. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.
- E. **Material and Equipment Manufacturing Date:** Products manufactured more than three years prior to date of delivery to site shall not be used, unless specified otherwise.

## 1.6 QUALITY ASSURANCE

- A. **Material and Equipment Qualifications:** Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a

single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

- B. Regulatory Requirements: Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70.
- C. Alternative Qualifications: Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.
- D. Service Support: The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.
- E. Manufacturer's Nameplate: Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.
- F. Modification of References: In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Design Professional.

#### 1.7 NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each panelboard; as specified in the technical sections or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

#### 1.8 ELECTRICAL REQUIREMENTS

Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.

#### 1.9 MECHANICAL REQUIREMENTS

All control equipment to provide the proper sequence of operation shall be furnished and installed by the electrical contractor.

All conduit and wiring for control purposes shall be furnished and installed as work of this electrical section. All control wiring shall be color coded.

#### 1.10 LOCKOUT REQUIREMENTS

Provide disconnecting means capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147. Mechanical isolation of machines and other equipment shall be in accordance with requirements of Division 23, "Mechanical."

### PART 2 PRODUCTS

Not used.

### PART 3 EXECUTION

#### 3.1 PAINTING OF EQUIPMENT

- A. Factory Applied: Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA IA 10030 corrosion-resistance test.

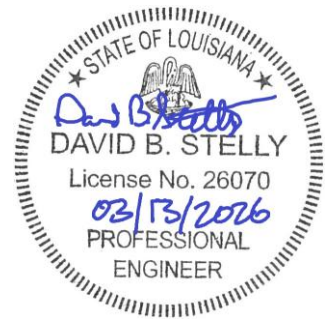
- B. Field Applied: Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria.

### 3.2 NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets, or industrial adhesive.

END OF SECTION 26 00 00

**SECTION 26 20 00  
INTERIOR DISTRIBUTION SYSTEM**



**PART 1 GENERAL**

**1.1 REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

**AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)**

- ANSI C80.1 (2020) Electrical Rigid Steel Conduit (ERSC)
- ANSI C80.3 (2020) Steel Electrical Metallic Tubing (EMT)

**AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)**

- ASTM B1 (2018) Hard-Drawn Copper Wire
- ASTM B8 (2017; R2023) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- ASTM D709 (2017) Laminated Thermosetting Materials

**INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)**

- ANSI/NETA ATS (2025) Acceptance Testing Specifications

**NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)**

- NEMA 10250 (2024) Enclosures for Electrical Equipment (1000 Volts Maximum)
- NEMA ICS 1 (2022) Industrial Control and Systems; General Requirements
- NEMA IA 10030 (2024) Industrial Control and Systems: Enclosures
- NEMA KS 1 (2013) Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
- NEMA ST 20 (2021) Dry-Type Transformers for General Applications
- NEMA TC 2 (2020) Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
- NEMA TC 3 (2021) Polyvinyl Chloride PVC Fittings for Use with Rigid PVC Conduit and Tubing
- NEMA TC 14 (2015) Reinforced Thermosetting Resin Conduit (RTRC) and Fittings
- NEMA WD 1 (1999; R2020) General Color Requirements for Wiring Devices
- NEMA WD 6 (2021) Wiring Devices - Dimensional Requirements
- NEMA Z535.4 (2023) Product Safety Signs and Labels

**NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)**

- NFPA 70 (2020) National Electrical Code
- NFPA 70E (2024) Electrical Safety in the Workplace

**UNDERWRITERS LABORATORIES INC. (UL)**

UL 1	(2005; R2023) Flexible Metal Conduit
UL 5	(2016; R2022) UL Standard for Safety Surface Metal Raceways and Fittings
UL 6	(2022) Electrical Rigid Metal Conduit - Steel
UL 20	(2025) General-Use Snap Switches
UL 50	(2024, Edition 14) Enclosures for Electrical Equipment
UL 67	(2025; Edition 13) Panelboards
UL 83	(2017; R2025) Thermoplastic-Insulated Wires and Cables
UL 360	(2013; R2025) Liquid-Tight Flexible Steel Conduit
UL 467	(11th Edition - 2022) Grounding and Bonding Equipment
UL 486A-486B	(2025) Wire Connectors
UL 486C	(2023; R2025) Splicing Wire Connectors
UL 489	(2025) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 506	(2017; R2022) Specialty Transformers
UL 508	(2024) Industrial Control Equipment
UL 510	(2020; R2024) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
UL 514A	(2024) Metallic Outlet Boxes
UL 514B	(2012; R2024) Conduit, Tubing and Cable Fittings
UL 651	(2011; R2022) Schedule 40 and 80 Rigid PVC Conduit
UL 797	(2007; R2023) Electrical Metallic Tubing -- Steel
UL 943	(2016; R2025) Ground-Fault Circuit-Interrupters
UL 1242	(2025) Electrical Intermediate Metal Conduit -- Steel
UL 1561	(2011; R2023) Dry-Type General Purpose and Power Transformers

## 1.2 RELATED REQUIREMENTS

Section 26 00 00, "Basic Electrical Materials and Methods," applies to this section with additions and modifications specified herein

## 1.3 SUBMITTALS: Submit the following:

- A. Manufacturer's Catalog Data
  - 1. Surge Protective Devices (SPD)
- B. Drawings
  - 1. Panelboards

## 1.4 QUALITY ASSURANCE

In each standard referred to herein, consider the advisory provisions to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears. Interpret references in these standards to "authority having jurisdiction," or words of similar meaning, to mean Design Professional.

## PART 2 PRODUCTS

### 2.1 MATERIALS AND EQUIPMENT

Materials, equipment, and devices shall, as a minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70.

### 2.2 CONDUIT AND FITTINGS

Shall be rigid steel (zinc-coated) conduit, rigid nonmetallic conduit, intermediate metal conduit (IMC), electrical metallic tubing (EMT), flexible metal conduit, and liquid-tight flexible conduit, conforming to the following:

- A. Rigid Steel Conduit (Zinc-Coated): ANSI C80.1, UL 6.
- B. Rigid Nonmetallic Conduit: PVC Type EPC-40 in accordance with NEMA TC 2.
- C. Intermediate Metal Conduit (IMC): UL 1242, zinc-coated steel only.
- D. Electrical Metallic Tubing (EMT): UL 797, ANSI C80.3.
- E. Flexible Metal Conduit: UL 1.
  - 1. Liquid-Tight Flexible Metal Conduit, Steel: UL 360.
- F. Fittings for Metal Conduit, EMT, and Flexible Metal Conduit: UL 514B. Ferrous fittings shall be cadmium or zinc-coated in accordance with UL 514B.
  - 1. Fittings for Rigid Metal Conduit and IMC: Threaded-type. Split couplings unacceptable.
  - 2. Fittings for EMT: Steel or Die Cast compression type.
- G. Fittings for Rigid Nonmetallic Conduit: NEMA TC 3.

### 2.3 SURFACE RACEWAY

Surface raceway shall be UL 5, two-piece painted steel, totally enclosed, snap-cover type.

### 2.4 OUTLET BOXES AND COVERS

UL 514A, cadmium- or zinc-coated.

### 2.5 CABINETS, JUNCTION BOXES, AND PULL BOXES

Volume greater than 100 cubic inches, UL 50, hot-dip, zinc-coated, if sheet steel.

### 2.6 WIRES AND CABLES

Wires and cables shall meet applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Wires and cables manufactured more than 12 months prior to date of delivery to site shall not be used.

- A. Conductors: Conductors No. 8 AWG and larger diameter shall be stranded. Conductors No. 10 AWG and smaller diameter shall be solid, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise. Conductor sizes and ampacities shown are based on copper, unless indicated otherwise. All conductors shall be copper.

1. Minimum Conductor Sizes: Minimum size for branch circuits shall be No. 12 AWG.

- B. Color Coding: Provide for service, feeder, branch, control, and signaling circuit conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in same raceway or box, other neutral shall be white with colored (not green) stripe. Color of ungrounded conductors in different voltage systems shall be as follows:

1. 120/240 volt, single phase: Black and red.

- C. Insulation: Unless specified or indicated otherwise or required by NFPA 70, power and lighting wires shall be 600-volt, Type THWN/THHN conforming to UL 83, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits shall be Type TW or TF, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

- D. Bonding Conductors: ASTM B 1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B 8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

## 2.7 SPLICES AND TERMINATION COMPONENTS

UL 486A-UL486B for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires shall be insulated, pressure-type in accordance with UL 486A-UL486B or UL 486C (twist-on splicing connector). Provide solderless terminal lugs on stranded conductors.

- A. Temperature Limitations: Contractor shall comply with the temperature limitations included in NEC Article 110-14(c). Ampacity rating of conductors shall be computed at the temperature rating of the equipment termination.

## 2.8 DEVICE PLATES

Provide UL listed, one-piece device plates for outlets to suit the devices installed. For metal outlet boxes, plates on unfinished walls shall be of zinc-coated sheet steel or cast metal having round or beveled edges. Plates on finished walls shall be nylon or lexan, minimum 0.03 inch wall thickness. Plates shall be same color as receptacle or toggle switch with which they are mounted. Screws shall be machine-type with countersunk heads in color to match finish of plate. Sectional type device plates will not be permitted. Plates installed in wet locations shall be gasketed and UL listed for "wet locations."

## 2.9 SWITCHES

- A. Toggle Switches: UL 20, totally enclosed with bodies of thermosetting plastic and mounting strap. Handles shall be ivory. Wiring terminals shall be screw-type, side-wired. Switches shall be rated quiet-type AC only, 120/277 volts, with 20 amp current rating and number of poles indicated.
- B. Disconnect Switches: NEMA KS 1. Provide heavy duty-type switches where indicated, where switches are rated higher than 240 volts, and for double-throw switches. Switches serving as motor-disconnect means shall be horsepower rated. Provide switches in NEMA enclosure per NEMA ICS 6.

## 2.10 RECEPTACLES

UL 498 and NEMA WD 1, specification grade, heavy-duty, grounding-type. Ratings and configurations shall be as indicated. Bodies shall be of ivory thermosetting plastic supported on a metal mounting strap. Dimensional requirements shall be per NEMA WD 6. Provide screw-type, side-wired wiring terminals. Connect grounding pole to mounting strap.

- A. Weatherproof Receptacles: Provide in cast metal box with gasketed, weatherproof, cast-metal cover plate and gasketed cap over each receptacle opening. Provide caps with a spring-hinged flap. Receptacle shall be UL listed for use in "wet locations with plug in use."
- B. Ground-Fault Circuit Interrupter (GFI) Receptacles: UL 943, duplex type for mounting in standard outlet box. Device shall be capable of detecting current leak of 6 milliamperes or greater and tripping per requirements of UL 943 for Class A GFI devices.
- C. Dryer Receptacles: NEMA 14-30 configuration, rated 30 amperes, 125/250 volts. Furnish one matching plug with each receptacle. Hubbell #HBL 9430A, Leviton #278, or equal.



- D. USB Charger Type Duplex Convenience Receptacles: NEMA WD 1, NEMA WD 6 for standard configurations and UL498. Comply with USB batter charging spec USB BC1.2. Duplex, 20A, 125V, 2P, 3W, grounded with dual USB, type A and C, solid state charging ports, equal to Hubbell #USB20AC5W, or Leviton #T5833.
- E. Surge Protective Receptacles: UL 1449, duplex type for mounting in standard outlet box. Devices shall be capable of EMI/RFI noise filtering and point-of-use surge protection up to 18,000 amp total surge current.

## 2.11 PANELBOARDS

UL 67 and UL 50. Panelboards for use as service disconnecting means shall additionally conform to UL 869. Panelboards shall be circuit breaker-equipped. Design shall be such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL. Where "space only" is indicated, make provisions for future installation of breaker sized as indicated. Panelboard locks shall be keyed same. Directories shall indicate load served by each circuit of panelboard. Directories shall also indicate source of service (upstream panel, switchboard, motor control center, etc.) to panelboard. Type directories and mount in holder behind transparent protective covering.

- A. Panelboard Buses: Support bus bars on bases independent of circuit breakers. Main buses and back pans shall be designed so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet.
- B. Circuit Breakers: UL 489, thermal magnetic-type having a minimum short-circuit current rating equal to the short-circuit current rating of the panelboard in which the circuit breaker shall be mounted. Breaker terminals shall be UL listed as suitable for type of conductor provided. Series rated circuit breakers and plug-in circuit breakers are unacceptable.
  - 1. Multipole Breakers: Provide common trip-type with single operating handle. Breaker design shall be such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.
- C. Manufacturer: GE Spectra bolt-on AVI, Square D Class 2441, Eaton Pow-R-Line series, or equal.
- D. Identification: Provide engraved laminated-plastic or metal nameplate for each device, mounted with corrosion-resistant screws.

## 2.12 SURGE PROTECTIVE DEVICES (SPD)

SPDs shall comply with NFPA 70 and UL 1449 4th Edition, Type 1. SPDs shall be field-mounted (installed external to electrical equipment) for low-voltage (120 to 600 V) power distribution and control equipment and connected with leads as short as possible to main lugs or circuit breaker in panel as directed. The SPD for Service Entrance application shall provide temporary overvoltage protection in addition to surge protection.

- A. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per mode shall not be less than the specified SPD rating. The peak surge current rating shall NOT be the arithmetic sum of the ratings of the individual MOVs in a given mode. SPD manufacturer shall provide independent 3rd party testing validating unit is capable of surviving a single surge at the specified rating. SPD types shall be provided as follows:
  - 1. Service Entrance Suppressor (Type "A"): SPD shall be rated at 125,000 amps per mode for 120/240V, single phase, three wire for service entrance switchboards or panelboards.
- B. Protection modes and UL 1449 voltage protection rating (VPR) for grounded wye circuits shall not exceed the following:

### 240Y/120 V

Line to Neutral:	700 V
Line to Ground:	700 V
Neutral to Ground:	700 V
Line to Line:	1200 V

- C. SPD monitoring options shall include tri-color protection status indicator lights, audible alarm with silence switch, Form C contacts rated at 5 A and 250 V (one normally open and one normally closed) for remote monitoring of protection status, and surge counter which measures, discriminates between, and indicates the level of surges.
- D. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground. Use crimped connectors and splices only. Wire nuts are unacceptable.
- E. Enclosures shall be fiberglass reinforced polyester, rated for outdoor use (NEMA 3R).
- F. Provide start-up and testing services of a factory-authorized and factory-trained local service representative. The tests shall include:
  - 1. Off-line Testing: Impulse injection to verify the system tolerances as well as verification of proper facility neutral-to-ground bond. Compare field test results to factory benchmark test parameters supplied with each individual unit.
  - 2. On-line Testing: Verify that suppression and filtering paths are operating with 100% protection as well as verification of proper facility neutral-to-ground bond by measuring neutral-to-ground current and voltage and by visual inspection.
  - 3. Voltage measurements from Line-to Ground (L-G), Line-to-Neutral (L-N), Line-to-Line (L-L), and Neutral-to-Ground (N-G), taken at the time of the testing procedure.
- G. SPD shall be equal to ABB (Current Technologies) "TG3" or Schneider Electric "EM" Series, with warranty support for fifteen (15) years from date of Substantial Completion. Manufacturer agrees to repair or replace SPDs that fail in materials or workmanship within specified warranty period.

## 2.13 GROUNDING AND BONDING EQUIPMENT

UL 467. Ground rods shall be copper-clad steel, with minimum diameter of 3/4 inch and minimum length of 10 feet.

## 2.14 VOICE/DATA SYSTEM

Provide system of jacks, outlet boxes, UTP cabling, conduits (within walls), terminal boards, and other accessories for voice/data system.

- A. Outlet Boxes for Voice/Data System: Standard type, as specified herein, 4 inches by 4 inches. Mount flush in finished walls at height specified for outlet receptacles.
- B. Cover Plates: Voice/data outlet cover plate shall be configured as a 4-port type with one voice and one data jack or as indicated on the plans. The voice and data jack shall be configured for Category 6. Provide permanent, typed address of each jack on cover plate. Cover plates shall be 2-port type. Voice jacks shall be ivory and data jack shall be gray. Utilize snap-in blank modules to close unused openings.
- C. Conduit Sizing: Unless otherwise indicated, conduit for voice/data outlets shall be minimum of 3/4-inch.
- D. Backboards: Interior grade plywood, 3/4-inch thick, size as indicated.
- E. Data Cable: All DATA cable runs between the device wall plate and the Patch Panel shall be Category 6 UTP 4-Pair cable with blue jacket color and shall meet or exceed the following specifications:

### Physical Specifications:

Description:	23 AWG (stranded) bare copper, 4-pair
Temperature:	-0 to +75 Deg C (Physical) -0 to +75 Deg C (Electrical)

Insulation: CMR (Non-Plenum)

Jacket: Blue with ripcord.

Applicable Specs: NEC 800-3 (B) (3)\  
NEMA "Low Loss Extended Frequency"  
UL Type MPP/CM Cable  
CSA PCC FT4/FT6, EIA/TIA-568

Flame Resistance: UL Type 910, CSA FT4/FT6, IEEE-383

#### Electrical Specifications:

Maximum Operating Voltage: 300 volts RMS

Maximum Continuous Current per Conductor @ 25 Deg C: 1.5 amps

Nominal Capacitance between Conductors of a Pair @ 1 kHz: 14.0 pF/ft

Nominal Capacitance between Conductors of a Pair @ 1 KHz: 0.175 mH/1000 ft

Maximum DC Resistance per 100m @ 20 Deg C: 9.38 Ohms

Characteristic Impedance @ 10 MHz: 100 Ohms ±15%

- F. Voice Cable: All multi-pair telephone cables shall be Category 6 UTP cable with white jacket meeting or exceeding the specifications listed above for data cable.
- G. Terminations: All terminations shall be made by Insulation Displacement Contact (IDC) method. Voice and Data cables shall terminate on modular patch panels in the data rack. Modular patch panels shall be of the same manufacturer as the modular jack, shall fit a standard 19-inch rack and shall be black in color.
- H. Equipment Rack
  - 1. Floor Mounted Rack: Equipment racks shall be 19-inch bolted, single sided, equipment racks. The racks shall be floor supported and made of steel, with pre-drilled mounting holes. Mounting holes shall have standard EIA spacings of 1/2" then 1 1/4". Height of rack shall be 7'. Racks shall be secured to floor using 3/8" hardware. Concrete sinkers shall be used on concrete floors.

## 2.15 NAMEPLATES

Provide as specified in Section 26 00 00, "Basic Electrical Materials and Methods."

## 2.16 FIRESTOPPING MATERIALS

Provide asbestos free firestopping system capable of maintaining an effective barrier against flame and gases. System shall be UL listed and comply with ASTM E 814. Include UL system number, UL listed print from manufacturer for each type of floor, wall, and ceiling penetration.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Electrical installations shall conform to requirements of NFPA 70 and to requirements specified herein.

- A. Service Entrance Identification: Service entrance disconnect devices, switches, and enclosures shall be labeled and identified as such.
1. Labels: Wherever work results in service entrance disconnect devices in more than one enclosure, as permitted by NFPA 70, each enclosure, new and existing, shall be labeled as one of several enclosures containing service entrance disconnect devices. Label, at minimum, shall indicate number of service disconnect devices housed by enclosure and shall indicate total number of enclosures that contain service disconnect devices. Provide laminated plastic labels conforming to paragraph entitled "Nameplates." Use lettering of at least 0.25 inch in height, and engrave on black-on-white matte finish. Service entrance disconnect devices in more than one enclosure, shall be provided only as permitted by NFPA 70.
- B. Wiring Methods: Provide insulated conductors installed in rigid steel conduit, IMC, rigid nonmetallic conduit, or EMT, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Grounding conductor shall be separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways. Minimum conduit size shall be 1/2 inch in diameter for low voltage lighting and power circuits. Conduit which penetrates fire-rated walls, fire-rated partitions, or fire-rated floors shall be firestopped in accordance with the paragraph entitled "Firestopping Materials," specified in this section.
1. Low Voltage Wiring: Low voltage wiring such as telephone, computer, control, etc. which is run open above ceiling shall be bundled, neatly trained and supported independently from the suspended ceiling system. Wiring shall not be supported by ceiling tiles, t-bars, or ceiling support wires. Install in accordance with NEC Article 720-11 and ANSI/EIA/TIA-569. Do not support wiring from conduit, piping, or ductwork.  
  
"Low voltage wiring shall be attached to the building structure at 4' on center (maximum), and routed as high as possible, free and clear of mechanical equipment, light fixtures, access panels and any other building equipment or items. Do not use tie straps or wire wraps to support cables. Each cable shall be continuous, with no splices from the source to the connected device. Routing shall be parallel or perpendicular to building walls. Support arrangement and tension on cables shall be sufficient to secure cables but shall not cause deformation or exceed minimum cable bending radius." Where wiring penetrates walls or ceilings, a metal conduit sleeve with bushings at each end, shall be provided for the penetration.
  2. Restrictions Applicable to EMT
    - a. Do not install underground.
    - b. Do not encase in concrete, mortar, grout, or other cementitious materials.
    - c. Do not use in areas subject to severe physical damage including but not limited to equipment rooms where moving or replacing equipment could physically damage the EMT.
    - d. Do not use in hazardous areas.
    - e. Do not use outdoors.
  3. Nonmetallic Conduit
    - a. Restrictions applicable to PVC Schedule 40
      - 1) Do not use above slab or grade.
  4. Restrictions Applicable to Flexible Conduit: Use only as specified in paragraph entitled "Flexible Connections."
  5. Underground Conduit: Rigid steel; steel IMC; PVC, Type EPC-40. Convert nonmetallic conduit to rigid, or IMC, steel conduit before rising through floor slab.
- C. Conduit Installation: Unless indicated otherwise, conceal conduit under floor slabs and within finished walls, ceilings, and floors. Keep conduit minimum 6 inches away from parallel runs of flues and steam or hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project.
1. Conduit Support: Support conduit by pipe straps, wall brackets, hangers, or ceiling trapeze. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded threaded studs, or spring-tension clamps on steel work. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Load applied to fasteners shall not exceed one-fourth proof test load. Fasteners attached to concrete ceiling shall be vibration resistant and shock-resistant. Holes cut to depth of more than 1 1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch

- in concrete joints shall not cut main reinforcing bars. Fill unused holes. In partitions of light steel construction, use sheet metal screws. In suspended-ceiling construction, run conduit above ceiling. Do not support conduit by ceiling support system. Conduit and box systems must be supported independently of both (a) tie wires supporting ceiling grid system, and (b) ceiling grid system into which ceiling panels are placed. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts. Installation shall be coordinated with above-ceiling mechanical systems to assure maximum accessibility to all systems. Spring-steel fasteners may be used for lighting branch circuit conduit supports in suspended ceilings in dry locations. Where conduit crosses building expansion joints, provide suitable expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means.
2. Directional Changes in Conduit Runs: Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent plaster, dirt, or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free clogged conduits of obstructions.
  3. Pull Wire: Install pull wires in empty conduits. Pull wire shall be plastic having minimum 200 pound tensile strength. Leave minimum 36 inches of slack at each end of pull wire.
  4. Locknuts and Bushings: Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least minimum single locknut and bushing. Locknuts shall have sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.
  5. Flexible Connections: Provide flexible steel conduit between 3 and 6 feet in length for equipment subject to vibration, noise transmission, or movement; and for motors. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size shall be 1/2 inch diameter. Provide liquidtight flexible conduit in wet and damp locations for equipment subject to vibration, noise transmission, movement or motors. Provide separate ground conductor across flexible connections.
- D. Boxes, Outlets, and Supports: Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways shall be cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces, and when specifically indicated. Boxes in other locations shall be sheet steel. Each box shall have volume required by NFPA 70 for number of conductors enclosed in box. Boxes for mounting lighting fixtures shall be minimum 4 inches square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers. Provide gaskets for cast-metal boxes installed in wet locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature; fixtures shall be readily removable for access to boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports, or make adequate provisions for distributing load over ceiling support members in an approved manner. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel. In open overhead spaces, cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to raceways on opposite sides of box, and support raceway with approved-type fastener maximum 24 inches from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.
1. Boxes: Boxes for use with raceway systems shall be minimum 1 1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes shall be minimum 4 inches square, except that 4 by 2 inch boxes may be used where only one raceway enters outlet.
  2. Pull Boxes: Construct of at least minimum size required by NFPA 70 of code-gauge aluminum or galvanized sheet steel, except where cast-metal boxes are required in locations specified herein. Provide boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.
- E. Mounting Heights: Mount panelboards, circuit breakers, and disconnecting switches so height of operating handle at its highest position is maximum 78 inches above floor. Mount receptacles 18 inches above finished floor, and other devices, as indicated. Measure mounting heights of wiring devices and outlets to center of device or outlet.

- F. Conductor Identification: Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 6 AWG and smaller diameter, color coding shall be by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, color coding shall be by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves.
- G. Splices: Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. 8 AWG and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.
- H. Covers and Device Plates: Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Install plates with alignment tolerance of 1/16 inch. Use of sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.
- I. Electrical Penetrations: Seal openings around electrical penetrations through fire resistance-rated walls, partitions, floors, and ceilings utilizing proper firestopping materials to maintain fire resistive integrity.
- J. Grounding and Bonding: In accordance with NFPA 70. Ground exposed, non-current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, and neutral conductor of wiring systems. Make ground connection to driven ground rods on exterior of building.
  - 1. Resistance: Maximum resistance-to-ground of grounding system shall not exceed 5 ohms under dry conditions. Where resistance obtained exceeds 5 ohms, contact Design Professional for further instructions.
- K. Repair of Existing Work: Repair of existing work, demolition, and modification of existing electrical distribution systems shall be performed as follows:
  - 1. Workmanship: Lay out work in advance. Exercise care where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces is necessary for proper installation, support, or anchorage of conduit, raceways, or other electrical work. Repair damage to buildings, piping, and equipment using skilled craftsmen of trades involved.
  - 2. Existing Concealed Wiring to be Removed: Existing concealed wiring to be removed shall be disconnected from its source. Remove conductors; cut conduit flush with floor, underside of floor, and through walls; and seal openings.
  - 3. Removal of Existing Electrical Distribution System: Removal of existing electrical distribution system equipment shall include equipment's associated wiring, including conductors, cables, exposed conduit, surface metal raceways, boxes, and fittings, back to equipment's power source as indicated.
  - 4. Continuation of Service: Maintain continuity of existing circuits of equipment to remain. Existing circuits of equipment shall remain energized. Circuits which are to remain but were disturbed during demolition shall have circuits wiring and power restored back to original condition.
- L. Panelboard Modifications: At the completion of the project, the Contractor shall provide a new typed index for all panels in this building affected by this work.

### 3.2 FIELD QUALITY CONTROL

- A. Devices Subject to Manual Operation: Each device subject to manual operation shall be operated at least five times, demonstrating satisfactory operation each time.
- B. 600-Volt Wiring Test: Test wiring rated 600 volt and less to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 500 volts to provide direct reading of resistance. Minimum resistance shall be 250,000 ohms.
- C. Transformer Tests: Perform test classified as routine in accordance with NEMA ST 20 on each transformer.
- D. GFI Receptacle Test: Test GFI receptacles with a "load" (such as a plug in light) to verify that the "line" and "load" leads are not reversed.
- E. Grounding System Test: Test grounding system to ensure continuity, and that resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for

resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to Design Professional, and indicate location of rods as well as resistance and soil conditions at time measurements were made.

- F. Voice/Data Cabling System Test: All UTP voice/data cables and associated connection hardware shall be tested to certify the performance category of the link as installed. All Category Category 6 station cables shall be tested in accordance with procedures laid out in EIA/TIA TSB 67 for the basic link. Written (printed) test results for each cable shall include all four of the primary field test parameter results. Any cable that fails testing shall be reported along with the procedures used to rectify the failure (i.e.. replaced cable, reterminated the jack, etc.). Contractor test shall utilize a Category 6 TSB 67 Level II compliant cable tester. Electronic results for each UTP Category 6 four pair cable shall be submitted as a part of the Contractors "as built" project performance acceptance records. In addition to the above information the documentation shall include a pass/fail indication for the specified cable, the test date, the serial number and software version of the scanner used, and a copy of the calibration certificate of the scanner. Necessary applications for reading the results shall be provided by the Contractor. If the vendor requires additional information concerning the testing requirements, refer to EIA/TIA TSB 67. This document can be found in the EIA/TIA Telecommunications Building Wiring Standards.

Each Category 6 cable shall meet the following performance from IDF termination to outlet jack

<u>Frequency</u>	<u>Maximum Attenuation (dB)</u>	<u>Maximum NEXT(dB)</u>
1	2.2	54.5
4	4.7	-49.5
11	7.0	-44
16	8.76	-40.5
20	10.0	-38.5
100	23.5	-27

END OF SECTION 26 20 00





**SECTION 26 50 00**  
**LIGHTING CONTROL SYSTEM**



**PART 1 GENERAL**

**1.1. RELATED DOCUMENTS**

- A. Section 26 51 00, "Interior Lighting."

**1.2. SUMMARY**

- A. The lighting control system specified in this section shall provide time-based, sensor-based (occupancy), and manual lighting control.
- B. The system shall be capable of turning lighting loads on/off as well as dimming lights (if lighting load is capable of being dimmed)
- C. All system devices shall be networked together enabling digital communication and shall be individually addressable.
- D. The system architecture shall be capable of enabling stand-alone groups (rooms) of devices to function in some default capacity even if network connectivity to the greater system is lost.
- E. The system architecture shall facilitate remote operation via a computer connection.
- F. The system shall not require any centrally hardwired switching equipment.
- G. The system shall be capable of wireless, wired, or hybrid wireless/wired architectures.

**1.3. SUBMITTALS**

- A. Product Datasheets (general device descriptions, dimensions, wiring details, nomenclature)
- B. Riser Diagrams – typical per room type (detailed drawings showing device interconnectivity of devices)
- C. Other Diagrams – as needed for special operation or interaction with other system(s)
- D. Example Contractor Startup/Commissioning Worksheet – must be completed prior to factory start-up
- E. Hardware and Software Operation Manuals
- F. Other operational descriptions as needed

**1.4. QUALITY ASSURANCE**

- A. All steps in sensor manufacturing process shall occur in the USA; including population of all electronic components on circuit boards, soldering, programming, wiring, and housing.
- B. All components and the manufacturing facility where product was manufactured must be ROHS compliant.
- C. All applicable products must be UL / CUL Listed or other acceptable national testing organization.

**1.5. COORDINATION**

- A. Coordinate lighting control components to form an integrated interconnection of compatible components.
- B. The installing contractor shall be responsible for a complete and functional system in accordance with all applicable local and national codes.

**1.6. WARRANTY**

All devices in lighting control system shall have a 5 year warranty.

**PART 2 PRODUCTS**

**2.1. MANUFACTURERS**

- A. Basis of design product: Acuity Brands Lighting, Inc. (nLight Network Control System) or subject to compliance and prior approval with specified requirements of this section, one of the following:
  - 1. Leviton Manufacturing Co. Inc. (GreenMAX DRC)
  - 2. Hubbell Control Solutions (NX)
- B. Substitutions:

1. Prior to rough-in, provide complete engineered shop drawings, including power wiring, with deviations from the original design highlighted in an alternate color, to the engineer for review and approval.
2. By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring.

## 2.2. SYSTEM REQUIREMENTS

- A. System shall have an architecture that is based upon three main concepts; 1) intelligent lighting control devices 2) standalone lighting control zones 3) network backbone for remote or time based operation.
- B. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.
- C. System must interface directly with intelligent LED luminaires such that only CAT-6 cabling is required to interconnect luminaires with control components such as sensors and switches (see *Networked LED Luminaire* section)
- D. Intelligent lighting control devices shall communicate digitally, require <4 mA of current to function (Graphic wall stations excluded), and possess RJ-45 style connectors.
- E. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher level network backbone.
- F. Devices within a lighting control zone shall be connected with CAT-6 low voltage cabling in any order.
- G. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.
- H. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.
- I. Power for devices within a lighting control zone shall come from either resident devices already present for switching (relay device) or dimming purposes, or from the network backbone. Standalone “bus power supplies” shall not be required in all cases.
- J. All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e. not in a remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.
- K. System shall have one or more primary wall mounted network control “gateway” devices that are capable of accessing and controlling connected system devices and linking into an Ethernet LAN.
- L. System shall use “bridge” devices that route communication and distribute power for up to 8 directly connected lighting zones together for purposes of decreasing system wiring requirements.
- M. System shall be capable of wirelessly connecting a lighting zone to a WiFi (802.11n) wireless data network for purposes of eliminating the “bridge” devices and all cabling that connects zones to bridge devices.
- N. WiFi enabled devices shall be able to detect when WiFi network is down and revert to a user directed default state.
- O. WiFi-enabled devices shall be capable of current monitoring
- P. WiFi-enabled devices shall utilize WPA2 AES encryption
- Q. WiFi-enabled devices shall be able to connect to 802.11b/g/n WiFi networks
- R. WiFi-enabled devices shall have at least one local RJ-45 port for communicating with nonWiFi-enabled system devices
- S. System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control profiles.
- T. Individual lighting zones shall be capable of being segmented into several “local” channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.

- U. Devices located in different lighting zones shall be able to communicate occupancy, photocell, and switch information via either the wired or WiFi backbone.
- V. System shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a spaces sequence of operation according to a time schedule so as to enable customized time-of-day, day-of-week utilization of a space. Note operating modes should be utilized only in manners consistent with local energy codes.
- a. Auto-On / Auto-Off (via occupancy sensors)
    - Zones with occupancy sensors automatically turn lights on when occupant is detected.
    - Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
    - Pressing a switch will turn lights off. The lights will remain off regardless of occupancy until switch is pressed again, restoring the sensor to Automatic On functionality.
  - b. Manual-On / Auto-Off (also called Semi-Automatic)
    - Pushing a switch will turn lights on.
    - Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
  - c. Manual-On to Auto-On/Auto-Off
    - Pushing a switch will turn lights on.
    - After initial lights on, zones with occupancy and/or photocell sensors turn lights on/off according to occupancy/vacancy and/or daylight conditions.
    - Sequence can be reset via scheduled (ex. daily each morning) events
  - d. Auto-to-Override On
    - Zones with occupancy sensors automatically turn lights on when occupant is detected.
    - Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.
    - Sequence can be reset via scheduled (ex. daily each morning) events
  - e. Manual-to-Override On
    - Pushing a switch will turn lights on.
    - Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.
    - Sequence can be reset via scheduled (ex. daily each morning) events
  - f. Auto On / Predictive Off
    - Zones with occupancy sensors automatically turn lights on when occupant is detected.
    - Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
    - If switch is pressed, lights turn off and a short “exit timer” begins. After timer expires, sensor scans the room to detect whether occupant is still present. If no occupancy is detected, zone returns to auto-on. If occupancy is detected, lights must be turned on via the switch.
  - g. Multi-Level Operation (multiple lighting levels per manual button press)
    - Operating mode designed specifically for bi-level applications
    - Enables the user to cycle through the up to four potential on/off lighting states using only a single button.
    - Eliminates user confusion as to which of two buttons controls which load
    - Three different transition sequences are available in order to comply with energy codes or user preference)
    - Mode available as a setting on all nLight devices that have single manual on/off switch (ex. nWSX, nPODM, nPODM-DX).
    - Depending on the sequence selected, every button push steps through relays states according to below table
    - In addition to achieving bi-level lighting control by switching loads with relays, the ability to command dimming outputs to “step” in a sequence that achieves bi-level operation is present.
- W. A taskbar style desktop application shall be available for personal lighting control.
- X. An application that runs on “smart” handheld devices (such as an Apple® iPhone®) shall be available for personal lighting control.
- Y. Control software shall enable logging of system performance data and presenting useful information in a web-based graphical format and downloadable to .CSV files.

Z. Control software shall enable integration with a BMS via BACnet IP.

AA. System shall provide the option of having pre-terminated plenum rated CAT-6 cabling supplied with hardware.

## 2.3. INDIVIDUAL DEVICE SPECIFICATIONS

### A. Control Module (Gateway)

- a. Control module shall be a device that facilitates communication and time-based control of downstream network devices and linking into an Ethernet.
- b. Devices shall have a user interface that is capable of wall mounting, powered by low voltage, and have a touch screen.
- c. Control device shall have three RJ-45 ports for connection to other backbone devices (bridges) or directly to lighting control devices.
- d. Device shall automatically detect all devices downstream of it.
- e. Device shall have a standard and astronomical internal time clock.
- f. Device shall have one RJ-45 10/100 BaseT Ethernet connection.
- g. Device shall have a USB port
- h. Each control gateway device shall be capable of linking 1500 devices to the management software.
- i. Device shall be capable of using a dedicated or DHCP assigned IP address.
- j. Network Control Gateway device shall be the following Sensor Switch model Series:

#### **nGWY2**

### B. Networked System Power (Relay) Packs

- a. Power Pack shall incorporate one or more Class 1 relays and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay(s), shall have an optional 2<sup>nd</sup> relay, 0-10 VDC dimming output, or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.
- b. Power Packs shall accept 120 or 277 VAC, be plenum rated, and provide Class 2 power to the system.
- c. All devices shall have two RJ-45 ports.
- d. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.
- e. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
- f. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
- g. Power Packs and Power Supplies shall be available that are WiFi enabled.
- h. Power (Secondary) Packs shall be available that provide up to 16 Amp switching of all lighting load types.
- i. Power (Secondary) Packs shall be available that provide up to 5 Amps switching of all lighting load types as well as 0-10 VDC dimming or fluorescent ballasts/LED drivers.
- j. Specific Power/Secondary Packs shall be available that are UL924 listed for switching of Emergency Power circuits.

### C. Networked Auxiliary Input / Output (I/O) Devices

- a. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½" knockout.
- b. Devices shall have two RJ-45 ports
- c. Communication and low voltage power shall be delivered to each device via standard CAT-6 low voltage cabling with RJ-45 connectors.
- d. Specific I/O devices shall have a dimming control output that can control 0-10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current (typically 40 or more ballasts).
- e. Specific I/O devices shall have an input that read a 0-10 VDC signal from an external device.
- f. Specific I/O devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event, run a local/remote control profile, or raise/lower a dimming output
- g. Specific I/O devices shall sense state of low voltage outdoor photocells

- h. Specific I/O devices shall enable RS-232 communication between lighting control system and Touch Screen based A/V control systems.

D. Networked System Wall Switches & Dimmers

- a. Devices shall recess into single-gang switch box and fit a standard GFI opening.
- b. Devices shall be available with zero or one integrated Class 1 switching relay.
- c. Communication and low voltage power shall be delivered to each device via standard CAT-6 low voltage cabling with RJ-45 connectors.
- d. All sensors shall have two RJ-45 ports.
- e. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.
- f. Devices shall be available in four colors (White).
- g. Devices with dimming control outputs can control 0-10 VDC dimmable ballasts by sinking up to 20 mA of current (typically 40 or more ballasts).
- h. Devices with capacitive touch buttons shall provide audible user feedback with different sounds for on/off, raise/lower, start-up, and communication offline.
- i. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
- j. Devices with mechanical push-buttons shall be made available with custom button labeling
- k. Devices with a single on button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which of two buttons (as is present in multi-button scenarios) controls which load is eliminated.

E. Networked System Scene Controllers

- a. Device shall have two to four buttons for selecting programmable lighting control profiles or acting as on/off switches.
- b. Device shall recess into single-gang switch box and fit a standard GFI opening.
- c. Devices shall provide LED user feedback.
- d. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-6 low voltage cabling with RJ-45 connectors.
- e. All sensors shall have two RJ-45 ports.
- f. Device shall be capable of reprogramming other devices in its zone so as to implement user selected lighting scene.
- g. Device shall be capable of selecting a lighting profile be run by the system's upstream Gateway so as to implement selected lighting profile across multiple zones (and not just its local zone).
- h. Device shall have LEDs indicating current selection.

F. Communication Bridges

- a. Device shall surface mount to a standard 4" x 4" square junction box.
- b. Device shall have 8 RJ-45 ports.
- c. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to Control Gateway.
- d. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a CAT-6 cabled connection.
- e. Device shall be careful of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.

2.4. LIGHTING CONTROL PROFILES

- A. Changes to the operation of the system shall be capable of being made in real-time or scheduled via lighting control profiles. These profiles are outlines of settings that direct how a collection of devices function for a defined time period.
- B. Lighting control profiles shall be capable of being created and applied to a single device, zone of devices, or customized group of zones.
- C. All relays and dimming outputs shall be capable of being scheduled to track or ignore information regarding occupancy, daylight, and local user switches via lighting control profiles.
- D. Every device parameter (e.g. sensor time delay and photocell set-point) shall be configurable via a lighting control profile.
- E. All lighting control profiles shall be stored on the network control gateway device and on the software's host server.
- F. Lighting control profiles shall be capable of being scheduled to run according to the following calendar options: start date/hour/minute, end date/hour/minute, and sunrise/sunset +/- timed offsets.

- G. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.
- H. Daylight savings time adjustments shall be capable of being performed automatically, if desired.
- I. Lighting control profile schedules shall be capable of being given the following recurrence settings: daily, weekday, weekend, weekly, monthly, and yearly.
- E. Software shall provide a graphical tool for easily viewing scheduled lighting control profiles.

## 2.5. MANAGEMENT SOFTWARE

- A. Every device parameter (e.g. sensor time delay and photocell set-point) shall be available and configurable remotely from the software
- B. The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current PIR Status, current Microphonics Status, remaining occupancy time delay(s), current photocell reading, current photocell inhibiting state, photocell transitions time remaining, current dim level, device temperature, and device relay state(s).
- C. The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.
- D. A printable network inventory report shall be available via the software.
- E. A printable report detailing all system profiles shall be available via the software.
- F. Software shall require all users to login with a User Name and Password.
- G. Software shall provide at least three permission levels for users.
- H. All sensitive stored information and privileged communication by the software shall be encrypted.
- I. All device firmware and system software updates must be available for automatic download and installation via the internet.
- J. Software shall be capable of managing systems interconnected via a WAN (wide area network)

## 2.6. SYSTEM ENERGY ANALYSIS & REPORTING SOFTWARE

- A. System shall be capable of reporting lighting system events and performance data back to the management software for display and analysis.
- B. Intuitive graphical screens shall be displayed in order to facilitate simple viewing of system energy performance.
- C. An "Energy Scorecard" shall be display that shows calculated energy savings in dollars, KWHr, or CO<sub>2</sub>.
- D. Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photocells, manual switching, etc).
- E. Energy savings data shall be calculated for the system as a whole or for individual zones.
- F. A time scaled graph showing all relay transitions shall be presented.
- G. A time scaled graph showing a zones occupancy time delay shall be presented
- H. A time scaled graph showing the total light level shall be presented.
- I. User shall be able to customize the baseline run-time hours for a space.
- J. User shall be able to customize up to four time-of-day billing rates and schedules.
- K. Data shall be made available via a .CSV file

## 2.7. SUPPORT FEATURES

- A. To facilitate start-up, all devices daisy-chained together (using CAT-6) shall automatically be grouped together into a functional lighting control zone.
- B. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.
- C. Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.
- D. All system devices shall be capable of being given user defined names.
- E. All devices within the network shall be able to have their firmware reprogrammed remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.
- F. All sensor devices shall have the ability to detect improper communication wiring and blink its LED in a specific cadence as to alert installation/startup personnel.

## 2.8. START-UP

- A. Provide a factory technician for start-up and on-site training of Owner's representative and maintenance personnel. Coordinate timing with the General Contractor. Provide a minimum of 4 hours of on-site training.

END OF SECTION 26 50 00





**SECTION 26 51 00  
INTERIOR LIGHTING**



**PART 1 GENERAL**

**1.1 REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

**AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)**

ANSI C78.377 (2024) American National Standard for Electric Lamps—Specifications for the Chromaticity of Solid State Lighting (SSL) Products

**ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)**

IES HB-10-11 (2011; Errata 1 & 2: 2015) IES Lighting Handbook, Tenth Edition

**NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)**

NEMA SSL 1 (2016) Electronic Drivers for LED Devices Arrays, or Systems

NEMA SSL 6 (2010) Solid State Lighting for Incandescent Replacement—Dimming

NEMA SSL 7A (2015; R2021) Phase Cut Dimming for Solid State Lighting for Incandescent Replacement

**NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)**

NFPA 70 (2020) National Electrical Code

NFPA 101 (2021) Life Safety Code

**UNDERWRITERS LABORATORIES INC. (UL)**

UL 20 (2025) General-Use Snap Switches

UL 924 (2016; R2025) Emergency Lighting and Power Equipment

UL 1598 (2021; R2024) Luminaires

**1.2 RELATED REQUIREMENTS**

Section 26 00 00, "Basic Electrical Materials and Methods," applies to this section, with the additions and modifications specified herein. Materials not considered to be lighting equipment or lighting fixture accessories are specified in Section 26 20 00, "Interior Distribution System." Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in this section.

**1.3 DEFINITIONS**

- A. Average Life: Time after which 50 percent will have failed and 50 percent will have survived under normal conditions.
- B. Total Harmonic Distortion (THD): The root mean square (RMS) of all the harmonic components divided by the total fundamental current.

**1.4 SUBMITTALS**

Submit the following: Data, drawings, and reports shall employ the terminology, classifications, and methods prescribed by the IESNA HB-10-11, as applicable, for the lighting system specified.

**A. Manufacturer's Catalog Data**

1. Solid State (LED) lighting fixtures
2. Dimmer switch
3. Photocell switch
4. Exit signs
5. Emergency lighting equipment
6. Occupancy sensors

## PART 2 PRODUCTS

### 2.1 SOLID STATE (LED) LIGHTING FIXTURES: ANSI C78.377A, NEMA SSL 1, UL 1598.

- A. Provide the lumen output, wattage, and color temperature indicated.
- B. Dimmer Switch: 0 -10 volt type for use with LED drivers.

### 2.2 PHOTOCELL SWITCH

UL 773A, hermetically sealed cadmium-sulfide or silicon diode type cell rated 120 volts ac, 60 Hz with single-throw contacts. Switch shall turn on at or below 3 footcandles and off at 2 to 10 footcandles. A time delay shall prevent accidental switching from transient light sources. Provide switch is a cast weatherproof aluminum housing with adjustable window slide, rated 1800 VA, minimum.

### 2.3 EXIT SIGNS

UL 924, NFPA 70, and NFPA 101. Exit signs shall be self-powered type.

- A. Self-Powered LED Type Exit Signs (Battery Backup): Provide with automatic power failure device, integral self-testing module and fully automatic high/low trickle charger in a self-contained power pack. Battery shall be sealed electrolyte type, shall operate unattended, and require no maintenance, including no additional water, for a period of not less than five years. LED exit sign shall have emergency run time of 1 1/2 hours (minimum).

### 2.4 EMERGENCY LIGHTING EQUIPMENT

UL 924, NFPA 70, and NFPA 101. Provide lamps in wattage indicated.

- A. Emergency Lighting Unit: Provide as indicated. Emergency lighting units shall be rated for 6 volts. Provide integral self-testing module.

### 2.5 SELF-TESTING MODULE

Self-testing module for exit signs and emergency lighting equipment shall perform the following functions:

- A. Continuous monitoring of charger operation and battery voltage with visual indication of normal operation and of malfunction.
- B. Monthly discharge cycling of battery with monitoring of transfer circuit function, battery capacity and emergency lamp operation with visual indication of malfunction. The battery capacity test may be conducted by using a synthetic load.
- C. Manual test switch to simulate a discharge test cycle.
- D. Module shall have low voltage battery disconnect (LVD) and brown-out protection circuit.

### 2.6 OCCUPANCY SENSORS

UL listed. Occupancy sensors and power packs shall be designed to operate on the voltage indicated. Sensors and power packs shall have circuitry that only allows load switching at or near zero current crossing of supply voltage. Occupancy sensor mounting as indicated. Sensor shall have an LED occupant detection indicator. Sensor shall have adjustable sensitivity and adjustable delayed-off time range of five minutes to fifteen minutes, minimum. Wall mounted sensors shall be ivory, ceiling mounted sensors shall be white. Ceiling mounted sensors shall have 360 degree coverage unless otherwise indicated. Wall mounted sensors shall have integral manual "off" switch.

- A. Ultrasonic sensor shall be crystal controlled and shall not cause detection interference between adjacent sensors.
- B. Infrared sensors shall have a daylight filter. Sensor shall have a fresnel lens that is applicable for indicated usage.
- C. Ultrasonic/Infrared Combination Sensor

Occupancy detection to turn lights on required both ultrasonic and infrared sensor detection. Lights shall remain on if either the ultrasonic or infrared sensor detects movement. Infrared sensor shall have lens selected for indicated usage and daylight filter to prevent short wavelength infrared interference. Ultrasonic sensor frequency shall be crystal controlled.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Set lighting fixtures plumb, square, and level with ceiling and walls, in alignment with adjacent lighting fixtures, and secure in accordance with manufacturers' directions and approved drawings. Installation shall meet requirements of NFPA 70. Mounting heights specified or indicated shall be to the bottom of fixture for ceiling-mounted fixtures and to center of fixture for wall-mounted fixtures. Obtain approval of the exact mounting for lighting fixtures on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed.

- A. Exit Signs and Emergency Lighting Units: Wire exit signs and emergency lighting units ahead of the switch to the normal lighting circuit located in the same room or area.
- B. Occupancy Sensor: Provide quantity of sensor units indicated as a minimum, provide additional units to have full coverage over controlled area. Full coverage shall provide hand and arm motion detection for office and administration type areas and walking motion for industrial areas, warehouses, storage rooms and hallways. Locate the sensor(s) as indicated and in accordance with the manufacturer's recommendations to maximize energy savings to avoid nuisance activation and deactivation due to sudden temperature or airflow changes and usage.

#### 3.2 FIELD QUALITY CONTROL

Upon completion of installation, conduct an operating test to show that equipment operates in accordance with requirements of this section.

- A. Electronic Dimming Driver: Test for full range of dimming capability. Observe for visually detectable flicker over full dimming range.
- B. Occupancy Sensor: Test sensors for proper operation. Observe light control over entire area being covered.

END OF SECTION 26 51 00



**SECTION 26 56 00**  
**EXTERIOR LIGHTING**



**PART 1 GENERAL**

**1.1 REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

**AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)**

AASHTO LTS	(2013; 6th Edition; R2025) Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals
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**AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)**

ANSI C136.3	(2014; 2020) Roadway and Area Lighting Equipment Luminaire Attachments
ANSI C136.21	(2024) Roadway Lighting Equipment - Vertical Tenons Used with Post-Top-Mounted Luminaires

**ASTM INTERNATIONAL (ASTM)**

ASTM A123/A123M	(2017; R2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A 153M	(2016a; R2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

**ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)**

IESNA HB-10-11	(2011; ERRATA 1 AND 2:2015) Lighting Handbook, 10 <sup>th</sup> Edition
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**INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)**

IEEE C2	(2023) National Electrical Safety Code
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**NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)**

NEMA IA 10030	(2024) Standard for Industrial Controls and Systems Enclosures
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**NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)**

NFPA 70	(2020) National Electrical Code
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**UNDERWRITERS LABORATORIES INC. (UL)**

UL 1598	(2021; R2024) Luminaires
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**1.2 RELATED REQUIREMENTS**

Section 26 00 00, "Basic Electrical Materials and Methods," applies to this section, with the additions and modifications specified herein.

**1.3 DEFINITIONS**

- A. Average Life: Time after which 50 percent will have failed and 50 percent will have survived under normal conditions.

## 1.4 SUBMITTALS

Submit the following:

### A. Manufacturer's Catalog Data.

1. Luminaires
2. Steel poles

### B. Drawings

1. Luminaire drawings
2. Poles

- a. Luminaire Drawings: Include dimensions, effective projected area (EPA), accessories, and installation and construction details. Photometric data, including zonal lumen data, average and minimum ratio, aiming diagram, and candlepower distribution data shall accompany shop drawings.
- b. Poles: Include dimensions, wind load determined in accordance with AASHTO LTS, pole deflection, pole class, and other applicable information.

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Steel Poles: Do not store poles on ground. Support poles so they are at least one foot above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

## PART 2 PRODUCTS

### 2.1 PRODUCT COORDINATION

Products and materials not considered to be lighting equipment or lighting fixture accessories are specified in Section 26 20 00, "Interior Distribution System". Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in Section 26 51 00, "Interior Lighting."

### 2.2 LUMINAIRES

UL 1598. Provide luminaires as indicated. Provide luminaires complete with lamps of number, type, and wattage indicated. Details, shapes, and dimensions are indicative of the general type desired, but are not intended to restrict selection to luminaires of a particular manufacturer. Luminaires of similar designs, light distribution, and brightness characteristics, and of equal finish and quality will be acceptable as approved.

### 2.3 POLES

Provide poles designed for wind loading of 100 miles per hour determined in accordance with AASHTO LTS while supporting luminaires having effective projected areas indicated. Poles shall be anchor-base type designed for use with underground supply conductors. Poles shall have oval-shaped handhole having a minimum clear opening of by 5 inches. Handhole cover shall be secured by stainless steel captive screws.

- A. Steel Poles: AASHTO LTS. Provide steel poles having minimum 11-gage steel with minimum yield/strength of 48,000 psi and factory finish. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire.

### 2.4 POLE FOUNDATIONS

Anchor bolts shall be steel rod having a minimum yield strength of 50,000 psi; the top 12 inches of the rod shall be galvanized in accordance with ASTM A 153/A 153M. Concrete shall be as specified in Section 03 30 00, "Cast-In-Place Concrete."

## PART 3 EXECUTION

### 3.1 INSTALLATION OF POLES

IEEE C2, NFPA 70, and to the requirements specified herein.

- A. Steel: Provide pole foundations with galvanized steel anchor bolts, threaded at the top end and bent 90 degrees at the bottom end. Provide galvanized nuts, washers, and ornamental covers for anchor bolts. Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath and the end of conduit ell. Adjust poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location.

### 3.2 GROUNDING

Ground noncurrent-carrying parts of equipment including metal poles, luminaires, mounting arms, brackets, and metallic enclosures as specified in Section 26 20 00, "Interior Distribution System." Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

### 3.3 FIELD QUALITY CONTROL

Upon completion of installation, conduct an operating test to show that the equipment operates in accordance with the requirements of this section.

END OF SECTION 26 56 00