SECTION 260943.23 - RELAY-BASED LIGHTING CONTROLS

Revise this Section by deleting and inserting text to meet Project-specific requirements.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

See "Sustainable Design Considerations" Article in the Evaluations for a discussion of sustainable design requirements that may impact the editing of this Section.

1. GENERAL
	* + 1. RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

* + - * 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
			1. SUMMARY
				1. Section Includes:

Lighting control relay panels.

Networked lighting control panels[**using control-voltage relays for switching and that are interoperable with HVAC DDC system**].

Manual switches and plates.

Field-mounted signal sources.

Conductors and cables.

* + - 1. DEFINITIONS

Retain terms that remain after this Section has been edited for a project.

* + - * 1. BAS: Building automation system.
				2. DDC: Direct digital control.
				3. IP: Internet protocol.
				4. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
			1. SUBMITTALS
				1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
				2. Manufacturer’s installation instructions shall be provided along with product data.
				3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
				4. Product Data: For each type of product.

Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, relays, manual switches and plates, and conductors and cables.

Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

Sound data including results of operational tests of central dimming controls.

Operational documentation for software and firmware.

* + - * 1. Shop Drawings: For each relay panel and related equipment.

Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.

Detail enclosure types and details for types other than NEMA 250, Type 1.

Detail wiring partition configuration, current, and voltage ratings.

Short-circuit current rating of relays.

Address Drawing: Reflected ceiling plan and floor plans, showing connected luminaires, address for each luminaire, and luminaire groups. Base plans on construction plans, using the same legend, symbols, and schedules.

Point List and Data Bus Load: Summary list of all control devices, sensors, ballasts, and other loads. Include percentage of rated connected load and device addresses.

Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.

Retain "Block Diagram" Subparagraphsubparagraph below when control is digital, PC or IP based.

Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.

* + - * 1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.

Retain "Coordination Drawings" paragraph below to require lighting controls to be connected to Section 230923 "Direct Digital Control (DDC) System for HVAC" or other integrated control system.

* + - * 1. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems.

Show interconnecting signal and control wiring, and interface devices that prove compatibility of inputs and outputs.

For networked controls, list network protocols and provide statements from manufacturers that input, and output devices comply with interoperability requirements of the network protocol.

* + - * 1. Qualification Data: For testing agency.

Retain "Field quality-control reports" paragraph below if Contractor is responsible for field quality-control testing and inspecting.

* + - * 1. Field quality-control reports.

Retain first paragraph below for PC- and IP-based control systems.

* + - * 1. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.
				2. Sample Warranty: For manufacturer's special warranty.
			1. CLOSEOUT SUBMITTALS
				1. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

Retain "Software and Firmware Operational Documentation" paragraph below for PC- and IP-based control systems.

* + - * 1. Software and Firmware Operational Documentation:

Software operating and upgrade manuals.

Program Software Backup: [**On USB drive.**] [**Username and password for manufacturer's support website.**]

Device address list.

Printout of software application and graphic screens.

Testing and adjusting of panic and emergency power features.

* + - 1. MAINTENANCE MATERIAL SUBMITTALS
				1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

Lighting Control Relays: Equal to <**Insert number**> percent of amount installed [**for each size indicated**], but no fewer than <**Insert number**>.

* + - 1. QUALITY ASSURANCE

Retain "Testing Agency Qualifications" paragraph below if Contractor is required to provide services of a qualified testing agency in "Field Quality Control" Article. See the Evaluations for discussion of NETA ATS and manufacturer's testing procedures.

* + - * 1. Testing Agency Qualifications: Accredited by NETA.

Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

* + - 1. DELIVERY, STORAGE, AND HANDLING
				1. Handle and prepare panels for installation according to NECA 407.
			2. WARRANTY

When warranties are required, verify with Director’s Representative that special warranties stated in this article are not less than remedies available to Director’s Representative under prevailing local laws.

* + - * 1. Special Warranty: Manufacturer agrees to repair or replace components of standalone multipreset modular dimming controls that fail in materials or workmanship within specified warranty period.

Failures include, but are not limited to, the following:

Damage from transient voltage surges.

<**Insert type of failure**>.

Verify available warranties for units and components and insert numbers in "Warranty Period" and "Extended Warranty Period" subparagraphs below.

Warranty Period: Cost to repair or replace any parts for [**two**] <**Insert number**> years from date of Substantial Completion.

Extended Warranty Period: Cost of replacement parts (materials only, f.o.b. the nearest shipping point to Project site), for [**eight**] <**Insert number**> years, that failed in service due to transient voltage surges.

1. PRODUCTS

Manufacturers and products listed in SpecAgent and MasterWorks Paragraph Builder are neither recommended nor endorsed by the AIA or AVITRU. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications. For definitions of terms and requirements for Contractor's product selection, see Section 016000 "Product Requirements."

* + - 1. SYSTEM DESCRIPTION
				1. Sequence of Operations: Input signal from field-mounted manual switches, or digital signal sources, shall open or close one or more lighting control relays in the lighting control panels. Any combination of inputs shall be programmable to any number of control relays.

Retain "Interface with HVAC DDC System" Paragraphparagraph below for interface with the HVAC DDC system. Coordinate with Section 230923 "Direct Digital Control (DDC) System for HVAC."

* + - * 1. Interface with HVAC DDC System: Hardware and software shall interface with HVAC DDC system to monitor, control, display, and record data for use in processing reports. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

Retain "Hardwired Points" or "Communication Interface" Subparagraphsubparagraph below. Retain first subparagraph if interface with the HVAC DDC system is through hardwired points and minimal interface is required. Retain second if extensive interface with the HVAC DDC system is required and is beyond what hardwired points can provide. Requirement may exclude some manufacturers. Coordinate with Section 230923 "Direct Digital Control (DDC) System for HVAC" or other integrated control system.

Hardwired Points:

Monitoring: On-off status, <**Insert monitoring point**>.

Control: On-off operation, <**Insert control point**>.

Communication Interface: Comply with [**ASHRAE 135**] <**Insert type of interface**>. The communication interface shall enable the HVAC DDC system operator to remotely control and monitor lighting from a HVAC DDC system operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the HVAC DDC system. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

* + - * 1. Surge Protective Device: Factory installed as an integral part of control components or field-mounted surge suppressors complying with UL 1449, SPD Type 2.
				2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
				3. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.
				4. Comply with UL 916.
			1. PERFORMANCE REQUIREMENTS

Delete "Seismic Performance" Paragraphparagraph below if performance requirements are indicated on Drawings. Model building codes and ASCE/SEI 7 establish criteria for buildings subject to earthquake motions. Coordinate requirements with structural engineer.

* + - * 1. Seismic Performance: Lighting control panels shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] <**Insert requirement**>.

Retain first subparagraph below to define the term "withstand" as it applies to this Project. Definition varies with type of building and occupancy and is critical to valid certification. Option is used for essential facilities where equipment must operate immediately after an earthquake.

The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified [**and the unit will be fully operational after the seismic event**]."

For life-safety components required to function after an earthquake (such as fire-sprinkler systems, components that contain hazardous content, and storage racks in structures open to the public), the Component Importance Factor is 1.5. For other components, the Component Importance Factor is 1.0 unless the structure is in Seismic Use Group III and component is necessary for continued operation of facility or failure of component could impair continued operation of facility, in which case the Component Importance Factor is 1.5.

Component Importance Factor: [**1.5**] [**1.0**].

See ASCE/SEI 7, Coefficients for Architectural Component Table and Seismic Coefficients for Mechanical and Electrical Components Table for requirements to be inserted in subparagraph below.

<**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

Retain one of first two articles below. "Lighting Control Relay Panels" Article is for a single lighting control relay panel, typically not more than 42 relays. Retain "Networked Lighting Control Panels" Article for multiple panels networked under unified control and with an optional connection to the HVAC DDC system.

* + - 1. LIGHTING CONTROL RELAY PANELS
				1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Intermatic, Inc.

Lithonia Lighting; Acuity Brands Lighting, Inc.

WattStopper; Legrand North America, LLC.

Or equal.

* + - * 1. Description: Standalone lighting control panel using mechanically latched relays to control lighting and appliances.
				2. Lighting Control Panel:

A single enclosure with incoming lighting branch circuits, control circuits, switching relays, and on-board timing and control unit.

A vertical barrier separating branch circuits from control wiring.

* + - * 1. Control Unit: Contain the power supply and electronic control for operating and monitoring individual relays.

Timing Unit:

365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.

Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.

[**Four**] <**Insert number**> independent schedules, each having [**24**] <**Insert number**> time periods.

Schedule periods settable to the minute.

Day-of-week, day-of-month, day-of-year with one-time or repeating capability.

[**10**] <**Insert number**> special date periods.

In "Sequencing Control with Override" Subparagraphsubparagraph below, two control units are available from some manufacturers.

Sequencing Control with Override:

Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.

Sequencing control shall operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.

Override control shall allow any relay connected to it to be switched on or off by a field-deployed manual switch or by an automatic switch, such as an occupancy sensor.

Override control "blink warning" shall warn occupants approximately [**five minutes**] <**Insert time**> before actuating the off sequence.

Nonvolatile memory shall retain all setup configurations. After a power failure, the controller shall automatically reboot and return to normal system operation, including accurate time of day and date.

* + - * 1. Relays:

Retain one of two subparagraphs below. Not all listed manufacturers can comply with requirements when retaining second subparagraph. Two-pole relays are available from some manufacturers.

Electrically operated, mechanically held single-pole switch, rated at 20 A at 277 V. Short-circuit current rating shall be not less than 5 kA. Control shall be three-wire, 24 V ac.

Electrically operated, mechanically held single-pole switch, rated at 20 A at 120 V for tungsten, 30 A at 277 V for ballast, 1.5 hp at 120 V, and 3 hp at 277 V. Short-circuit current rating shall be not less than 14 kA. Control shall be three-wire, 24 V ac.

* + - * 1. Power Supply: NFPA 70, Class 2, sized for connected equipment, plus 20 percent spare capacity. Powered from a dedicated branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, low-voltage inputs, field-installed occupancy sensors, and photo sensors.

Alternatives to "Operator Interface" Paragraphparagraph below are available from some manufacturers. Alternatives include hand-held portable PCs, personal digital assistants, and mobile telephones.

* + - * 1. Operator Interface:

Integral alphanumeric keypad and digital display, and intuitive drop-down menus to assist in programming.

Log and display relay on-time.

Connect relays to one or more time and sequencing schemes.

* + - 1. NETWORKED LIGHTING CONTROL PANELS

Revise this article for selected control protocol based on the need for flexibility, interoperability, and the most appropriate user interface.

* + - * 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Intermatic, Inc.

Lithonia Lighting; Acuity Brands Lighting, Inc.

WattStopper; Legrand North America, LLC.

Or equal.

* + - * 1. Description: Lighting control panels using mechanically latched relays to control lighting and appliances. The panels shall be capable of being interconnected with digital communications to appear to the operator as a single lighting control system.
				2. Lighting Control Panels:

A single enclosure with incoming lighting branch circuits, control circuits, switching relays, and on-board timing and control unit.

A vertical barrier separating branch circuits from control wiring.

Not all manufacturers place all features, listed in "Main Control Unit" Paragraphparagraph below, into the main network panel. Instead, some features may be repeated in each slave panel. Revise paragraph below as necessary, depending on manufacturers.

* + - * 1. Main Control Unit: Installed in the main lighting control panel only; powered from the branch circuit of the standard control unit.

Ethernet Communications: Comply with [**TCP/IP**] <**Insert network protocol**> protocol. The main control unit shall provide for programming of all control functions of the main and all networked slave lighting control panels including timing, sequencing, and overriding.

Retain "Compliance with ASHRAE 135" Subparagraphsubparagraph below for HVAC DDC system control network. Revise as required for other network protocols.

See "Communication Networks for Lighting Controls" Article in the Evaluations for discussion of communication network options.

Compliance with ASHRAE 135: Controllers shall support serial MS/TP and Ethernet IP communications and shall be able to communicate directly via DDC system for HVAC RS-485 serial networks and Ethernet 10Base-T networks as a native device.

Web Server: Display information listed below over a standard Web-enabled server for displaying information over a standard browser.

A secure, password-protected login screen for modifying operational parameters, accessible to authorized users via Web page interface.

Panel summary showing the master and slave panels connected to the controller.

Controller diagnostic information.

Show front panel mimic screens for setting up controller parameters, input types, zones, and operating schedules. These mimic screens shall also allow direct breaker control and zone overrides.

Timing Unit:

365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.

Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.

[**Four**] <**Insert number**> independent schedules, each having [**24**] <**Insert number**> time periods.

Schedule periods settable to the minute.

Day-of-week, day-of-month, day-of-year with one-time or repeating capability.

[**16**] <**Insert number**> special date periods.

In "Time Synchronization" Subparagraphsubparagraph below, the typical value ranges from one hour to 24 hours.

Time Synchronization: The timing unit shall be updated not less than every <**Insert number**> hour(s) with the network time server.

Sequencing Control with Override:

Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.

Sequencing control shall operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.

Override control shall allow any relay connected to it to be switched on or off by a field-deployed manual switch or by an automatic switch, such as an occupancy sensor.

Override control "blinking warning" shall warn occupants approximately [**five minutes**] <**Insert time**> before actuating the off sequence.

Activity log, storing previous relay operation, including the time and cause of the change of status.

Download firmware to the latest version offered by manufacturer.

* + - * 1. Standard Control Unit, Installed in All Lighting Control Panels: Contain electronic controls for programming the operation of the relays in the control panel, contain the status of relays, and contain communications link to enable the digital functions of the main control unit. Comply with UL 916.

Electronic control for operating and monitoring individual relays, and display relay on-time.

Nonvolatile memory shall retain all setup configurations. After a power failure, the controller shall automatically reboot and return to normal system operation.

Integral keypad and digital-display front panel for local setup, including the following:

Blink notice, time adjustable from software.

Ability to log and display relay on-time.

Capability for accepting downloadable firmware so that the latest production features may be added in the future without replacing the module.

* + - * 1. Relays:

Retain one of two subparagraphs below. Not all listed manufacturers can comply with requirements when retaining second subparagraph. Two-pole relays are available from some manufacturers. See the Evaluations for discussion of additional relay features.

Electrically operated, mechanically held single-pole switch, rated at 20 A at 277 V. Short-circuit current rating shall be not less than 5 kA. Control shall be [**three-wire, 24 V ac**] [**digital control network**].

Electrically operated, mechanically held single-pole switch, rated at 20 A at 120 V for tungsten, 30 A at 277 V for ballast, 1.5 hp at 120 V, and 3 hp at 277 V. Short-circuit current rating shall be not less than 14 kA. Control shall be [**three-wire, 24 V ac**] [**digital control network**].

* + - * 1. Power Supply: NFPA 70, Class 2, UL listed, sized for connected equipment, plus not less than 20 percent spare capacity. Powered from a dedicated branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, low-voltage inputs, field-installed occupancy sensors, and low-voltage photo sensors.
				2. Operator Interface: At the main control unit, provide interface for a tethered connection of [**a portable PC running MS Windows**] <**Insert digital device and operating system**> for configuring all networked lighting control panels using setup software designed for the specified operating system. Include one portable device for initial programming of the system and training of Director’s Representative's personnel. That device shall remain the property of Director’s Representative.
				3. Software:

Menu-driven data entry.

Online and offline programming and editing.

Provide for entry of the room or space designation for the load side of each relay.

Monitor and control all relays, showing actual relay state and the name of the automatic actuating control, if any.

Size the software appropriate to the system.

* + - 1. MANUAL SWITCHES AND PLATES

Coordinate use of manual switches in this article with required control and override functions, with occupancy sensor applications where used, and with switch and wall-plate finish specified in Section 262726 "Wiring Devices."

* + - * 1. Push-Button Switches: Modular, momentary contact, three wire, for operating one or more relays and to override automatic controls.

Retain both subparagraphs below if required.

Integral green LED pilot light to indicate when circuit is on.

Internal white LED locator light to illuminate when circuit is off.

* + - * 1. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.
			1. FIELD-MOUNTED SIGNAL SOURCES
				1. Daylight Harvesting Switching Controls: Comply with Section 260923 "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal shall be compatible with the relays.
				2. Indoor Occupancy Sensors[**and Extreme-Temperature Occupancy Sensors**]: Comply with Section 260923 "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal shall be compatible with the relays.
			2. CONDUCTORS AND CABLES
				1. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
				2. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than [**No. 18**] [**No. 22**] [**No. 24**] AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
				3. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than [**No. 14**] [**No. 16**] [**No. 18**] AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
				4. Twisted-Pair Data Cable: [**Category 5e**] [**Category 6**] [**Category 6a**].

Retain one of two subparagraphs below.

1. EXECUTION
	* + 1. EXAMINATION
				1. Receive, inspect, handle, and store panels according to NECA 407.
				2. Examine panels before installation. Reject panels that are damaged or rusted or have been subjected to water saturation.
				3. Examine elements and surfaces to receive panels for compliance with installation tolerances and other conditions affecting performance of the Work.
				4. Proceed with installation only after unsatisfactory conditions have been corrected.
			2. INSTALLATION OF WIRING
				1. Comply with NECA 1.
				2. Wiring Methods:

Retain one of first three subparagraphs below.

Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters.

Install cables in raceways and cable trays except within consoles, cabinets, desks, counters, accessible ceiling spaces, and gypsum board partitions where unenclosed wiring method may be used.

Install conductors and cables concealed in accessible ceilings, walls, and floors where possible.

Conceal raceway and cables except in unfinished spaces.

Provide plenum-rated cable, where installed exposed or in open cable tray, within environmental airspaces, including plenum ceilings.

* + - * 1. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."

Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

* + - 1. INSTALLATION OF PANELS
				1. Comply with NECA 1.
				2. Install panels and accessories according to NECA 407.

Retain first paragraph below if seismic controls are required for Project. Coordinate with Drawings.

Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

Ensure that, whatever height is retained for top of trim in first paragraph below, the operating handle of topmost switch or circuit breaker, in on position, is not higher than 79 inches (2000 mm) above finished floor or grade.

* + - * 1. Mount top of trim [**90 inches (2286 mm)**] <**Insert dimension**> above finished floor unless otherwise indicated.
				2. Mount panel cabinet plumb and rigid without distortion of box.
				3. Install filler plates in unused spaces.
			1. IDENTIFICATION
				1. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
				2. Identify field-installed conductors, interconnecting wiring, and components.; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
				3. Create a directory to indicate loads served by each relay; incorporate OwnerDirector’s Representative's final room designations. Obtain approval before installing. Use a PC or typewriter to create directory; handwritten directories are unacceptable.
			2. FIELD QUALITY CONTROL

Coordinate testing requirements with Section 262416 "Panelboards."

* + - * 1. Testing and Inspection Responsibility:

Retain one of first four subparagraphs below. Retain first subparagraph below if Owner will hire an independent testing agency. Retain second subparagraph below to require Contractor to hire an independent testing agency. Retain third subparagraph below to require a factory-authorized service representative to perform tests and inspections. Retain fourth subparagraph below to require Contractor to perform tests and inspections and, if required, retain option to require Contractor to arrange for the assistance of a factory-authorized service agent.

Director’s Representative will engage a qualified testing agency to perform tests and inspections.

Engage a qualified testing agency to perform tests and inspections.

Engage a factory-authorized service representative Company Service Advisor to test and inspect components, assemblies, and equipment installations, including connections.

Perform tests and inspections[**with the assistance of a Company Service**].

* + - * 1. Tests and Inspections:

Retain option in first subparagraph below if panelboards with factory-installed SPD are specified.

List of tests is from that stated in NETA ATS, Paragraphparagraph 7.6, "Circuit Breakers," and Paragraphparagraph 7.19.1, "Surge Arrestors, Low-Voltage." Coordinate tests and test values with testing agency and manufacturer.

Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers described below [**and low-voltage surge arrestors**]. Certify compliance with manufacturer's test parameters.

Circuit-Breaker Tests:

Compare nameplate with Drawings and Specifications.

Inspect physical and mechanical conditions.

Inspect anchorage and alignment.

Verify that the units are clean.

Operate the circuit breaker to ensure smooth operation.

Inspect bolted electrical connections for high resistance using one or more of the following methods:

A low-resistance ohmmeter.

Verify tightness of bolted electrical connections by calibrated torque wrench.

Thermographic survey.

Inspect operating mechanism, contacts, and arc chutes in unsealed units.

Perform adjustments for final protective device settings according to the overcurrent protective device coordination study. Comply with requirements in Section 260573.16 "Coordination Studies."

Perform insulation resistance tests for one minute on each pole, phase-to-phase, and phase-to-ground with the circuit breaker closed and across each pole using manufacturer's published data.

Perform a contact/pole-resistance test.

Perform insulation-resistance tests on control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be for one minute. Follow manufacturer's written instructions for solid-state units.

Determine long-time pickup and delay by primary current injection.

Determine short-time pickup and delay by primary current injection.

Determine ground-fault pickup and time delay by primary current injection.

Determine instantaneous pickup by primary current injection.

Test functions of the trip unit by means of secondary injection.

Perform minimum pickup voltage tests on shunt trip and close coils according to manufacturer's published data.

Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, anti-pump function, and trip unit battery condition. Reset trip logs and indicators.

Verify operation of charging mechanism.

Retain "Surge Arrestor Tests" Subparagraphsubparagraph below if retaining low-voltage surge arrestors above.

Surge Arrestor Tests:

Compare nameplate with the Contract Documents.

Inspect physical and mechanical conditions.

Inspect anchorage, alignment, grounding, and clearances.

Verify that the units are clean.

Inspect bolted electrical connections for high resistance using one or more of the following methods:

Low-resistance ohmmeter.

Verify tightness of bolted electrical connections by calibrated torque wrench.

Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.

Perform an insulation-resistance test on each arrestor, phase terminal-to-ground using voltage according to manufacturer written instructions.

Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

* + - * 1. Lighting control panel will be considered defective if it does not pass tests and inspections.

Retain paragraph below if tests and inspections are performed by Contractor or manufacturer's field-service representative engaged by Contractor.

* + - * 1. Prepare test and inspection reports, including a certified report that identifies lighting control panels and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.
			1. STARTUP SERVICE
				1. [**Engage a factory-authorized service representative Company Service Advisor** **to perform**] [**Perform**] startup service.

Complete installation and startup checks according to manufacturer's written instructions.

Confirm correct communications wiring, initiate communications between panels, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.

<**Insert startup steps if any**>.

* + - 1. ADJUSTING
				1. Occupancy Adjustments: When requested within [**12**] <**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**] <**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.
			2. SOFTWARE SERVICE AGREEMENT

Services in this article may not be allowed for publicly funded projects.

* + - * 1. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for [**two**] <**Insert number**> years.
				2. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [**two**] <**Insert number**> years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

Upgrade Notice: At least [**30**] <**Insert number**> days to allow Director’s Representative to schedule and access the system and to upgrade computer equipment if necessary.

* + - 1. DEMONSTRATION
				1. [**Engage a factory-authorized service representative Company Service Advisor** **to train**] [**Train**] Director’s Representative's maintenance personnel to adjust, operate, and maintain the control unit and operator interface.

END OF SECTION 260943.23