## PART 1 – GENERAL

### 1.01 SECTION INCLUDES

A. Lighting control system requirements.

### 1.02 RELATED SECTIONS

A. Section 20 30 14, Seismic Performance Requirements for Equipment
B. Section 20 70 26, Common Materials and Methods for Electrical Systems
C. Section 26 05 24, Low Voltage Wires and Cables
D. Section 26 24 24, Circuit Breaker and Panelboards
E. Section 26 50 00, Lighting
F. Section 27 13 01, Communication Cables and Related Equipment
G. Typical Lighting Control Systems, Standard Drawing ES87
H. Summary Table of Lighting Control Requirements, Standard Drawing ES88

### 1.03 MEASUREMENT AND PAYMENT

A. General: Lighting control system, as specified herein, will not be measured separately for payment but will be paid for as part of the Contract lump-sum price for Electrical Work as indicated in the Bid Schedule of the Bid Form.

### 1.04 REFERENCES

A. Institute of Electrical and Electronics Engineers (IEEE):
   
   1. IEEE C62.41 IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits

B. California Code of Regulations (CCR):
   
   1. Title 24 Building Energy Efficiency Standards

C. Illuminating Engineering Society of North America (IES):
   
   1. IES Lighting Handbook, Reference and Application

D. National Electric Manufacturing Agency (NEMA):
   
   1. NEMA 250 Enclosure for Electrical Equipment (1000 Volts Maximum)
   2. NEMA PB 1 Panelboards
   3. NEMA PB 1.1 General Instructions for Proper Handling, Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or less
E. National Fire Protection Association (NFPA):
   1. NFPA 70 National Electrical Code

F. Underwriters Laboratories Inc. (UL):
   1. UL 50 Standard for Safety Enclosures for Electrical Equipment,
      Non-environmental Considerations
   2. UL 67 Standard for Safety Panelboard
   3. UL 916 Standards for Safety Energy Management Equipment
   4. UL 924 Standards for Emergency Lighting and Power Equipment

G. International Organization for Standardization (ISO):
   1. ISO 9001 Quality Management Systems

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures, and Section 01 33 23, Shop
   Drawings, Product Data, and Samples, for submittal requirements and procedures.

B. Submit product data including the following:
   1. Catalog sheets and specifications
   2. Ratings, configurations, wiring diagrams, dimensions, service conditions, options,
      and features

C. Submit shop drawings including the following:
   1. Single line, schematic, block, and wiring diagrams
   2. Equipment layout of lighting control system components
   3. Plan view details and component topologies
   4. Photometric drawings and network riser diagrams
   5. Hard copy of lighting control programming, program flow chart, and time
      schedule matrix

D. Installation procedures: Include tools and materials list, mounting templates, and
   dimensions.
E. Submit test reports including the following:
   1. Certified test reports of factory and field tests performed
   2. Title 24 Acceptance Testing Documentation in accordance to Title 24, Part 6
   3. Seismic analysis report

F. Software: Include copy of lighting control software on USB drive with user manual.

G. Manufacturer’s certificates: Include certificate ensuring products meet or exceed specified requirements.

H. Submit the operation and maintenance manual, in accordance with Section 01 78 23, Operations and Maintenance Data, including the submittal items mentioned above and the following:
   1. Sequence of operation identifying control operation for each room or space
   2. Preventive maintenance procedure
   3. Spare parts list and ordering form
   4. Troubleshooting guide for common issues

1.06 QUALITY ASSURANCE

A. Manufacturer requirements: The manufacturer of the equipment shall have a minimum of five years manufacturing experience and be the manufacturer of the major components within the assembly.

B. Manufacturer’s Certification: A qualified factory-trained manufacturer’s representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer’s recommendations. The Contractor shall provide three copies of the manufacturer’s representative’s certification.

C. Installer requirements: The installer shall be a certified lighting control professional or technician with experience performing the Work of this section.

D. Performance requirements: System components shall be manufactured, assembled, and installed to maintain performance criteria stated by the manufacturer that is free from defects, damage, or failure.

E. Code and certification requirements:
   1. System components shall be UL listed and certified.
   2. Installed system components shall comply with the latest National Electrical Code (NEC).
   3. The manufacturer shall be ISO 9001 and Restriction of Hazardous Substances Directive (RoHS) certified.

F. Coordination requirements: The lighting control system shall be comprised of non-proprietary hardware and software and shall be capable of integrating with existing lighting control systems.
G. Seismic requirements: Provide submittals in accordance with Section 20 30 14, Seismic Performance Requirements for Equipment.

1.07 DELIVERY, HANDLING, AND STORAGE

A. Equipment shall be delivered, handled and stored in accordance with manufacturer’s instructions until ready for installation.

1.08 PROJECT CONDITIONS

A. Maintain environmental conditions for temperature, humidity, and ventilation within limits recommended by the manufacturer. Products shall not be installed under environmental conditions outside manufacturer’s specifications.

1.09 WARRANTY

A. The manufacturer shall provide a five year warranty beginning after the date of Acceptance, which include repair, parts, labor, travel, and living expenses for the manufacturer’s certified technician.

PART 2 – PRODUCTS

2.01 SYSTEM REQUIREMENTS

A. The lighting control system (LCS) shall include hardware, software, control devices, networking devices, and associated items required for complete operation. The LCS shall be configured based on site-specific requirements for normal or emergency use as indicated. Refer to Standard Drawings ES87 and ES88 for typical lighting control systems.

B. General Requirements:

1. Input Voltage: 120/277 VAC plus or minus ten percent
2. Input frequency: 60 hertz
3. The LCS shall comply with Title 24, Section 110.9, Mandatory Requirements for Lighting Control Devices and Systems, Ballasts, and Luminaires.
4. The LCS shall be capable of monitoring and controlling lighting control zones based on time-of-day scheduling, astronomical time, daylight savings, holidays, and support control inputs for photocells, control switches, dimmers, and occupancy sensors.
5. The LCS shall facilitate remote and local configuration, monitoring, reporting for operation of groups, channels, zones, schedules, and general system information of luminaires and devices.
6. The LCS shall be relay based, offered in eight, 24, and 48 relay configurations.
7. The LCS shall be fail-safe. In conditions where failure is detected within the system, functional luminaires will bypass ON, regardless of pre-programmed operating conditions.

8. Lighting control panelboards designated for emergency use shall meet UL-924 and NFPA 70 requirements. Additional normally closed contactors shall be provided for use in emergency lighting applications for automatic bypass of relays upon loss of normal power.

9. Self-contained emergency lighting control relays shall be UL-924 listed and provide control that is independent of the LCS. Self-contained units shall only be permitted for luminaires in difficult access areas or on switched circuits and shall be equipped with auxiliary contacts for remote testing with a push to test button on the unit for local testing.

10. The LCS shall be expandable for future lighting loads and be capable of interfacing with existing LCS and equipment on the same network.

11. Scheduled events for time schedules, photocells, and other control devices shall run autonomously.

C. Hardware:

1. Enclosure: NEMA 1, surface mounted, lockable, hinged door
2. Interior: Provide isolation of Class 1 and Class 2 circuits
3. Control Relay: Mechanically latched, SPST, 24VDC, 30A
4. Control Contactor: Electrically held, 4-pole, SPST, NC, 30A, 600V
5. Digital Inputs: Support of digital switches, IO modules, 0-10V analog photocell inputs, momentary/maintained contact closure inputs, analog sensor inputs, daylighting and digital occupancy sensors.

6. Power Supply: The enclosure shall be supplied with a power supply that contains protection against over-current and over-voltage conditions. Ensure the power supply is sufficiently rated to provide power to control equipment and input devices within the control system.

7. Relay Bypass: Control relays shall be equipped with an actuator for manual override with visual status indicators when in ON/OFF/BYPASS mode for troubleshooting or operating system loss.

8. Memory: The lighting controller shall contain non-volatile memory. Upon loss of power, previously programmed items shall be retained within the system.

9. Remote: The remote shall be a hand-held device capable of two-way infrared communications between the LCS and operator with the ability to read and modify parameters for time schedules and control devices.

D. Software:

1. The lighting control software shall be non-proprietary, windows compatible, and be easily obtainable on the manufacturer’s website.

2. Software license encryption through an external device of any kind shall not be permitted.
3. Provide three additional copies of lighting control software.

4. LCS software shall consist of the following requirements:
   a. Time-of-day, astronomical time, daylight savings, and holiday scheduling
   b. Monitoring and control of luminaires and control devices
   c. Status indications for alarm conditions
   d. Modification of control logic for sequence of operation
   e. User interface for local and remote connections
   f. Data logging

E. Network Devices:

1. Network Manager: The LCS shall be equipped with a device to manage network communications, BACnet MS/TP-based, and controllable over hard-wired data network or Ethernet LAN.

2. Items managed on the network shall be client line interface (CLI) over Secure Shell 2 (SSH2) security protocol over network and viewable on a web browser-based user interface for system control, scheduling, and monitoring.

3. Conductors used for networking shall be shielded and twisted-pair, rated for RS-485 data communications.

F. Control Devices:

1. Photocell
   a. Photocells shall conform to UL 773 and UL 916 requirements.
   b. Exterior photocells shall be mounted in an area free from obstruction, facing north, with no direct exposure to nighttime illumination.
   c. Interior photocells shall be mounted above existing luminaires and located central to the area requiring control.
   d. The photocell shall include an internal time delay and dead band to preclude cycling of luminaires.
   e. The photocell shall be capable of overriding time-of-day, astronomical time schedules due to unforeseen overcast conditions, and in response to parking structure daylighting requirements.

2. Control Switch
   a. The control switch shall be user programmable, wall mounted, momentary push-button type, offered in 1 through 8 button configurations, and shall be mounted adjacent to the lighting control panelboard and within the station agent booth.
   b. The control switch shall support wired, ethernet, or RJ45 connections.
c. Override switch: The control switch shall allow manual control of overriding existing programmed lighting control functions. Luminaires shall be commanded ON or OFF contingent upon emergency, maintenance, or demand response requirements as indicated.

d. Dimmer switch: The dimmer switch shall be compatible with 0-10V dimmable drivers/ballasts and is capable of dimming connected loads in single or multi-way applications.

3. Occupancy Sensor
   a. Occupancy sensors shall conform to WD7 standards.
   b. Occupancy sensors shall be passive infrared (PIR) or dual-technology PIR/Ultrasonic with 360-degree coverage. Utilize multiple segmented lens with internal grooves to eliminate dust and residue build-up.
   c. The occupancy sensor shall turn luminaires off or reduce light levels automatically through a time delay when a room or area is vacated.
   d. Wireless: Wireless occupancy sensors shall communicate directly to compatible receiving devices through a radio frequency communications link or wireless gateway. The sensor shall contain a visible method of indication to verify the detection of motion during testing and to establish an active connection has been made to receiving devices.

2.02 LEGACY SYSTEMS

Existing lighting installations, not under immediate consideration of overall improvement, shall be considered as legacy lighting installations.

A. Powerline Carrier (PLC):

1. General Requirements:
   a. Input Voltage: 120/277 VAC plus or minus ten percent
   b. Input frequency: 60 hertz
   c. Control equipment shall comply with Title 24, Part 2, California Building Code.
   d. The PLC shall comply with ISO 14908, Control Network Protocol Standard.
   e. The PLC shall comprise of a self-contained lighting controller installed near the light source and a segment manager capable of receiving, transmitting, controlling, and monitoring data over existing conductors to self-contained lighting controllers over a mesh network.
   f. The PLC shall be capable of monitoring and controlling lighting control zones based on time-of-day scheduling, astronomical time, daylight savings, holidays, and support control inputs for photocells, control switches, dimmers, and occupancy sensors.
g. Individual lighting zones shall be capable of being segmented into several channels for occupancy, photocell, and switch functionalities to control sequence of operation.

h. The PLC shall be fail-safe. In conditions where failure is detected within the system, functional luminaires will bypass ON, regardless of pre-programmed operating conditions.

i. The PLC system shall work in conjunction with self-contained emergency lighting control relays, UL-924 compliant, for luminaires designated for emergency use.

2. Network Devices:
   a. PLC Segment Manager
      1) Input Voltage: 120/277 VAC plus or minus ten percent
      2) Input frequency: 60 hertz
      3) The segment manager shall be din railed mounted and installed in a cabinet or enclosure properly rated for the environment.
      4) The segment manager shall support up to 250 additional PLC lighting controllers.
      5) Provide RS485 or RS232 serial interface for the control and monitoring of MODBUS devices.
      6) Items managed on the network shall be viewable on a web browser-based user interface for system control, scheduling, and monitoring.
      7) Conductors used for networking shall be shielded and twisted-pair, rated for RS-485 data communications.

   b. PLC Lighting Controller:
      1) Input Voltage: 120/277 VAC plus or minus ten percent
      2) Input frequency: 60 hertz
      3) Enclosure Rating: P65 or higher
      4) The controller shall be capable of pulse width modulation and 0-10V dimming.
      5) The controller shall automatically designate another lighting controller within the mesh network to act as a repeater in its place if communication is lost between itself and the segment manager.
      6) The controller shall measure voltage, current, power, power factor, accumulated energy consumption, and capture the number of lamp burning hours.

   c. PLC Software:
      1) Software shall be non-proprietary, windows compatible, and easily accessible for download on the manufacturer’s website.
      2) PLC software shall consist of the following requirements:
a) Time-of-day, astronomical time, daylight savings, and holiday scheduling
b) Alarm and message indicators
c) Support of SOAP/XML interface for remote access
d) Monitoring and supervision of control points
e) Modification of control logic for sequence of operation
f) Modification of control setpoints and timing parameters
g) Capacity to run third party software for word processing, spreadsheets, and data management
h) Capable of data logging with automatic transfer to historical data repositories

2.03 FACTORY TESTING

A. The factory service shall provide adequate testing of the supplied equipment and software to ensure that the system performs as intended by the specification. BART engineering and maintenance personnel shall be trained on aspects of operation and maintenance of the system. Ensure system load connections are to the electrical drawing and that the control scenarios are operating properly.

PART 3 – EXECUTION

3.01 INSTALLATION

A. The Contractor shall furnish, install and terminate conductors and associated conduits external to any factory supplied equipment.

B. Conductors wiring and routing shall be per the manufacturer’s recommendations and as shown on the Contract Drawings.

3.02 FIELD QUALITY CONTROL

A. Provide the services of a qualified factory-trained manufacturer’s representative to assist the Contractor in starting-up and programming the system for a period of two working days. The manufacturer’s representative shall be factory-trained and shall have a thorough knowledge of the software, hardware and system programming.

B. The Contractor shall provide three copies of the manufacturer’s field startup.
C. The following system programming shall be provided by the factory trained manufacturer’s representative:

1. Assist the owner in developing a practical control scenario for each application
2. Program the owner supplied control scenario
3. Explain the operation of the control program to the owner

D. Verify complete system operation including hardware, software and communication devices.

E. Verify networking performance with interfacing systems by other manufacturers.

3.03 TRAINING

A. See Section 01 79 00, Demonstration and Training, for specific training requirements.

B. The Contractor shall provide a training session for up to five BART employees for three workdays during normal work hours. Location for training shall consist of in classroom and on-site training.

C. The training session shall be conducted by a manufacturer’s qualified representative. Training program shall include instructions on the control system, programming, and other major components.

D. The training program shall include:

1. System review of system components and their function
2. System review of management software and its function
3. Hands-on training with the lighting controller and related programming devices to develop experience with software and control applications.

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