SECTION 260943.19 - WIRELESS-NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.   SUMMARY

   A.   Section Includes:
      1.   System Software Interfaces.
      2.   System Backbone and Integration Equipment.
      3.   Wireless Networked Devices.

   B.   Related Requirements:
      1.   Div. 26: Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
      2.   Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

2.   DEFINITIONS

   A.   Data Bus: A wired interface used to communicate with connected devices.

   B.   Device: A collective term for bus or wireless connected devices, including fluorescent ballasts, LED drivers, incandescent luminaires, manual switches, switching relays, sensors, and similar.

   C.   Global: Communication between devices in otherwise separate spaces using a bridging device or system controller.

   D.   Group: A set of devices that communicate together.

   E.   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.

   F.   Scene: Digital light level associated with a preset.

   G.   System Backbone: Devices used to connect and manage otherwise separate spaces, including bridging devices and gateways or system controllers. Used to expose devices to software configuration via TCP/IP.

3.   PREINSTALLATION MEETINGS

A.   Preinstallation Conference: Conduct conference at Enter Project Location.

B.   Preinstallation Coordination Meeting(s): For digital-network lighting controls. Conduct meeting(s) Enter Meeting Venue before Insert construction activity.
1.   Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect and <enter other required attendees> of scheduled meeting dates.
2.   Engage factory-authorized service representative to attend preinstallation conference and review the submittal drawing, sequence of operation, and device installation best practices with Project team.
3.   Engage factory-authorized service representative to perform cellular signal strength measurements during site walk through and compare to Project plans to verify the placement of cellular antennas and quantity of lighting control system RF access points.

4.   ACTION SUBMITTALS

A.   Product Data:
1.   Bill of Materials necessary to install the networked lighting control system.
2.   Product Specification Sheets indicating general device descriptions, dimensions, electrical specifications, wiring details, and nomenclature.
3.   Information Technology (IT) connection information pertaining to interconnection with facility IT networking equipment and third-party systems.
4.   Other Diagrams and Operational Descriptions - as needed to indicate system operation or interaction with other system(s).

B.   Shop Drawings:
1.   Riser Diagrams showing device wiring connections of system backbone and typical per room/area type.

5.   INFORMATIONAL SUBMITTALS

A.   Contractor Startup/Commissioning Worksheet.

B.   Service Specification Sheets indicating general service descriptions, including startup, training, post-startup support, and service contract terms.

C.   Field quality-control reports.

D.   Sample Warranty: For manufacturer's special warranty.

6.   CLOSEOUT SUBMITTALS

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A.   Maintenance Contracts:
    1.   Hardware and Software Operation Manuals
    2.   Maintenance service agreement.
    3.   Software service agreement.

B.   Warranty documentation.

7.   QUALITY ASSURANCE

A.   Manufacturer Qualifications:
    1.   Phone Support: Toll-free technical support available from manufacturer through an online tool to schedule a technical support appointment and provide 24/7 emergency support.
    2.   Remote Support: Manufacturer capable of providing remote support and ability to virtually connect with customers to address issues with visual guidance overlaid on images of real-world objects.
    3.   Cellular Connectivity: Manufacturer capable of cellular connectivity to a networked lighting control systems available to provide remote support within the continental United States.
    4.   On-Site Support: Manufacturer capable of providing a 72-hour, on-site response time within the continental United States.
    5.   Service Contracts: Manufacturer capable of providing service contracts for continued on-site and remote support of the lighting control system post-installation for terms up to 10 years from substantial completion, including:
        a.   Remote and on-site emergency response.
        b.   Remote system performance checks.
        c.   Remote diagnostics.
        d.   Replacement parts.

8.   WARRANTY

A.   Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period.
    1.   Failures include, but are not limited to, the following:
        a.   Faulty operation of lighting control hardware.
        b.   Faulty operation of lighting control firmware.
        c.   Insert failure modes.
    2.   Minimum Warranty Period: Five years from date of shipment.
    3.   Extended Warranty Period: Insert number year(s) from date of shipment.

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PART 2 - PRODUCTS

1. ## SYSTEM COMPLIANCE

    A.   System components manufactured in accordance with UL 916 and UL 924 standards where applicable.
    B.   System components manufactured in accordance with CFR Title 47, Part 15 standards where applicable.
    C.   System components manufactured in accordance with ISED Canada RSS-247 standards where applicable.
    D.   System components manufactured in accordance with IFT-008-2015 and NOM-208-SCFI-2016 standards where applicable.
    E.   System listed as qualified under DesignLights Consortium Networked Lighting Control System Specification v5.0.
    F.   Performance Criteria:
        1.   Regulatory Requirements:
            a.   Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. ## SYSTEM PERFORMANCE REQUIREMENTS

    A.   System Architecture:
        1.   System architecture based upon the following concepts:
            a.   Networkable intelligent lighting control devices.
            b.   Standalone lighting control zones using distributed intelligence.
            c.   Optional system backbone for remote, time-based, and global operation.
        2.   Intelligent lighting control devices with individually addressable network communication capability and having one or more basic lighting control components including: occupancy sensor, photosensor, relay, dimming output, contact closure input, analog 0-10 V(dc) input, and manual wall station capable of indicating switching, dimming, and/or scene control. Combining one or more of these components into a single device enclosure permissible to minimize overall system device count.
        3.   System capable of interfacing directly with networked luminaires such that either low-voltage network cabling or wireless RF communication is used to interconnect networked luminaires with control components such as sensors, switches, and system backbone.
        4.   Networked luminaires and intelligent lighting control devices support individual (unique) configuration of device settings and properties, with such configuration residing within the networked luminaires and intelligent control devices.

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1. Lighting control zones consisting of one or more networked luminaires and intelligent lighting control devices capable of providing automatic control from sensors (occupancy and/or photosensor) and manual control from local wall stations without requiring connection to a higher-level system backbone.
   a. Lighting control zones support at least 128 devices per zone.
   b. Capable of being networked with a higher-level system backbone to provide time-based control, control from inputs or systems external to control zone, and remote configuration and monitoring through a software interface.
2. Networked luminaires and intelligent lighting control devices with distributed intelligence programming stored in non-volatile memory, such that following any loss of power the lighting control zones operate according to their defined default settings and sequence of operations.
3. System to include one or more system controllers that provide time-based control.
4. System controller provides means of connecting the lighting control system to a system software interface and building management systems via BACnet/IP or BACnet MS/TP protocol.
5. System controller supports both low-voltage wired and wireless RF communication within a single controller device.
6. System devices support firmware update, either remotely or from within the application space, for purposes of upgrading functionality at a later date.
7. System capable of reporting lighting system events and performance data to management software for display and analysis.

B. Wireless Networked Control Zone Characteristics:
   1. No wired connections between networked devices required for the purposes of system communications.
   2. Multiple wireless networking protocols supported:
      a. Standards-based, distributed star topology type of protocol for 900 MHz communication, to support lighting control applications and IoT applications.
      b. Bluetooth standard protocol for 2.4 GHz communication that supports direct connection to smartphone or tablet, to support device configuration, control applications, and IoT without requiring the use of a system backbone.
   3. Wireless network must be self-healing, such that the loss of backbone or local communication between devices does not result in the loss of local control of lights in the space.
   4. Wireless network communication must support uniform and instant response such that all luminaires in a lighting control zone respond immediately and synchronously in response to a sensor or wall station signal.
   5. Communication of control signals from sensors and wall stations to networked luminaires and wireless load-control devices occur directly, without any communication, interpretation, or translation of information through a backbone device such as a wireless access point, communication bridge, or gateway.
   6. All wireless communication between lighting control components supports the following five tiers of security measures.

a.	Data encryption.
b.	Firmware protection.
c.	Tamper-proof hardware.
d.	Authenticated user access.
e.	Mutual device authentication.
7.	Wireless devices use AES encryption to secure communication with a unique encryption key generated for each programmed site.
8.	Wireless devices use signed firmware to ensure that unmodified, authentic software is always installed.
9.	Wireless networked devices capable of communicating a minimum distance of 150 ft. (45 m) between devices under typical site conditions accounting for typical environmental conditions and building construction materials encountered within commercial indoor lighting environments.
10.	Minimum Line-of-Sight Communication Range: 1000 ft. (304 m) under ideal environmental conditions.
11.	Wireless devices self-identify when communication to system controller cannot be accomplished or when communication to the system controller is lost.
a.	Self-identification not required for wireless switches or battery-powered devices.
12.	Wireless devices self-establish connection to system controller through other devices if direct communication cannot be accomplished or when communication to system controller is lost.
a.	Communication path formation to utilize existing, wireless networked devices located between system controller and respective end devices.
b.	No additional hardware for formation of networked communication path between a system controller and end devices required.
c.	Automatic connection not required for wireless switches or battery-powered devices.
13.	Networked control devices suitable for control of egress or emergency light sources without additional, externally mounted UL 924 shunting or 0-10 V(dc) disconnect devices, to provide a compliant sequence of operation while reducing the overall installation and wiring costs of the system. Capable of supporting the following sequence of operation:
a.	Line-Voltage Power Sensing: Devices listed as UL 924 emergency relays that automatically close load-control relay and provide 100 percent light output upon detection of loss of power sensed via line voltage connection to normal power.
b.	Normal-Power-Broadcast Sensing: Devices listed as UL 924 emergency relays that automatically close load-control relay and provide 100 percent light output upon loss of a wireless normal-power broadcast from devices connected to normal power.

C.	System Integration Capabilities:
1.	Capable of interface with third-party building management systems (BMS) to support two-way communication using BACnet/IP protocol, BACnet MS/TP protocol, and RESTful API including the following system integration capabilities:

          a.   "Write" messages for control of individual devices, including control of relay and dimming output.

          b.   "Write" messages for control of groups of devices through a single command, including control of relay and dimming output of all devices.

          c.   "Read" messages for individual device status information.

              1.   Available status will vary based on device type and capabilities, which may include relay state, dimming output, power measurement, occupancy sensor status, and photosensor light measurement.

          d.   "Read" messages for group status information for occupancy, relay state, and dimming output.

          e.   Activation of pre-defined system Global Profiles.

    2.   Activation of Global Profiles from third-party systems via dry contact closure output signals or digital commands via RS-232 or RS-485.

    3.   Activation of demand response levels from Demand Response Automation Servers (DRAS) via OpenADR 2.0a protocol.

D.   Supported Sequence of Operations:

    1.   Control Zones:

          c.   Local Control Zones: Networked luminaires and intelligent lighting control devices installed in an area (also referred to as a group of devices) capable of transmitting and tracking occupancy sensor, photosensor, and manual switch information within at least 48 unique control zones to support different and reconfigurable sequences of operation within area. These will also be referred to as local control zones.

          d.   Adjacent Control Zones: Networked luminaires and intelligent lighting control devices capable of tracking occupancy broadcasts from adjacent zones. When this feature is enabled, luminaire output for a vacant zone will reduce to a configurable dimmed state if one or more adjacent zones are occupied. Luminaires will turn off when both primary and adjacent zones are vacant.

          e.   Global Control Zones: Networked luminaires and intelligent lighting control devices located in different areas able to transmit and track information within at least 128 system-wide control zones to support required sequences of operation that may span across multiple areas. Occupancy, photosensor inhibit, and switch commands available across multiple controllers.

    2.   Wall Station Capabilities:

          c.   Wall stations support the following capabilities:

              1.   On/Off of a local or global control zone.

              2.   Continuous dimming control of light level of a local or global control zone.

          d.   Multi-Way Control: Multiple wall stations capable of controlling the same local or global control zones, to support "multi-way" switching and dimming control.

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3. Occupancy Sensing Capabilities:
    a. Occupancy sensors configurable to control a local or global zone.
    b. Multiple occupancy sensors capable of controlling the same local or global zones. This capability combines occupancy sensing coverage from multiple sensors without consuming multiple control zones.
    c. Occupancy sensing sequence of operation modes:
        1. On/Off Occupancy Sensing.
        2. Partial-On Occupancy Sensing.
        3. Partial-Off Occupancy Sensing.
        4. Vacancy Sensing (Manual-On / Automatic-Off).
    d. On/Off, Partial-On, and Partial-Off Occupancy Sensing Modes Sequence of Operation:
        1. Occupancy automatically turn lights on to a designated level when occupancy is detected. Designated occupied light level support at least 100 dimming levels.
        2. Occupancy sensors automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. Designated unoccupied dim level support at least 100 dimming levels.
        3. System capable of combining Partial-Off and Full-Off operation by dimming lights to a designated level when vacant and turning the lights off completely after an additional time delay.
        4. Photosensor readings, if enabled in occupancy sensing control zone, automatically adjust light levels during occupied or unoccupied conditions as necessary.
        5. Wall station activation changes the dimming level or turn lights off as selected by the occupant. Lights optionally remain in this manually specified light level until the zone becomes vacant. Upon vacancy, normal sequence of operation resumes.
    e. Vacancy Sensing or Manual-On/Automatic-Off Mode Sequence of Operation:
        1. Activation of a wall station is required turn lights on. System capable of programming the zone to turn on to either a designated light level or previous user-set light level. Initially occupying the space without using a wall station must not result in lights turning on.
        2. Occupancy sensors automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. Designated unoccupied dim level support at least 100 dimming levels.
        3. System capable of dimming the lights when vacant and then turning the lights off completely after an additional time delay.

4. System capable of an "automatic grace period" immediately following detection of vacancy, during which time any detected occupancy results in the lights reverting to the previous level. After the grace period has expired, the use of a wall station is required to turn lights on.

5. Photosensor readings, if enabled in the Occupancy Sensing control zone, capable of automatically adjusting the light level during occupied or unoccupied conditions as necessary.

6. Wall station interaction changes the dimming level or turn lights off as selected by occupant. Lights remain at manually specified light level until zone becomes vacant; normal sequence of operation resumes upon vacancy.

    a. Occupancy time delays before dimming or shutting off lights separately programmable for all control zones from 15 seconds to 2 hours.

4. Photosensor Sensing Capabilities (Automatic Daylight Sensing):

    a. Photosensor devices configurable to control a local zone.

    b. Photosensor-Based Control:

        1. Continuous Dimming: Control zone automatically adjusts dimming output in response to photosensor readings, to maintain a minimum light level consisting of both electric light and daylight sources. Photosensor response configurable to adjust set point and dimming rates.

5. Schedule Capabilities:

    a. System capable of time schedules for time-of-day to override devices including offsets from dusk and dawn.

    b. System capable of providing a visible "blink warning" five minutes prior to the end of the schedule.

    c. Wall stations may be programmed to provide timed extensions/overrides that turn the lights on for an additional time period.

        1. Timed override/extension duration programmable for each individual device, zone of devices, or customized group of devices, from five minutes to 12 hours.

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6.   Global Profile Capabilities:
   a.   System capable of automatically modifying the sequence of operation for selected devices in response to any of the following:
      1.   Time-of-day schedule.
      2.   Contact closure input state.
      3.   Manually triggered wired wall station input.
      4.   RS-232/RS-485 command to wired input device.
      5.   BACnet input command.
   b.   Global Profile Capabilities:
      1.   Global Profiles stored within and executed from the system controller (via internal timeclock). Dedicated software host or server is not required to be online to support automatic scheduling and/or operation of Global Profiles.
      2.   Global Profile time-of-day schedules capable of recurrence settings including daily, specific days of week, every "n" number of days, weekly, monthly, and yearly. Lighting control global profile schedules support definition of start date, end date, end after "n" recurrences, or never ending.
      3.   Daylight savings time adjustments capable of being performed automatically, if desired.
      4.   Global Profile holiday schedules follow recurrent settings for specific U.S. holiday dates regardless if they always occur on a specific date or are determined by day/week of the month.
      5.   Global Profiles capable of being scheduled to run according to timed offsets relative to sunrise or sunset. Sunrise/sunset times automatically derived from location information using an astronomical clock.
      6.   Software management interface capable of displaying a graphic calendar view of profile schedules for each control zone.
      7.   Global Profiles capable of manual activation directly from system controller, specially programmed wired input devices, scene-capable wired wall stations, and software management interface.
      8.   Global Profiles selectable to apply to a single device, zone of devices, or customized group of devices.
      9.   Global Profile Configurable Parameters:
         a.   Fixture light level.
         b.   Occupancy time delay.
         c.   Response to occupancy sensors (including enabling/disabling response).
         d.   Response to daylight sensors (including enabling/disabling response).
         e.   Enabling/disabling of wall stations.

    c. Local and Global Profiles backed up and stored on software's host server such that Profile backup can be applied to a replacement system controller or wired wall station.

  7. System supports automated demand response capabilities with automatic reduction of light level to at least three levels of demand response, configurable for each output device.

3. SYSTEMS SOFTWARE INTERFACES

 A. Management Interface:

  1. Web-based management interface for remote system control, live status monitoring, and configuration of lighting control settings and schedules.

  2. Compatible with industry-standard web browser clients.

  3. Minimum of 100 unique password-protected user accounts.

  4. Minimum of three user permission levels: read-only, read and change settings, and full administrative system access.

  5. Capable of restricting access for user accounts to specific devices within the system.

  6. All system devices capable of being given user-defined names.

  7. Device identification information displayed in the Management interface including:

    a. Model number.

    b. Model description.

    c. Serial number or network ID.

    d. Manufacturing date code.

    e. Custom label.

    f. Parent network device.

  8. Management interface capable of displaying live status of a networked luminaire or intelligent control device including:

    a. Luminaire on/off status.

    b. Dim level.

    c. Power consumption.

    d. Device temperature.

    e. PIR occupancy sensor status.

    f. Microphonic occupancy sensor status.

    g. Remaining occupancy time delay.

    h. Photosensor reading.

    i. Active Profiles.

  9. Management interface capable of displaying and modifying the current active settings of a networked luminaire or intelligent control device including:

    a. Dimming trim levels.

    b. Occupancy sensor and photosensor enable/disable.

    c. Occupancy sensor time delay and light level settings.

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      a.   Occupancy sensor response (normal or vacancy).

      b.   Photosensor setpoints and transition time delays.

2. Management interface capable of applying settings changes for a zone of devices or a group of selected devices using a single action that does not require the user to apply settings changes for each individual device.

3. Management interface capable of compiling a printable network inventory report.

4. Management interface capable of compiling a printable report detailing all system profiles.

5. All sensitive information stored encrypted.

6. System software updates available for automatic download and installation via the Internet.

B. System Energy Analysis and Reporting:

1. Intuitive graphical screens to facilitate simple viewing of system energy performance.

2. Energy Scorecard: Summarized display that indicates calculated energy savings in dollars or KWh.

3. Software calculates allocation of energy savings by control measures including occupancy sensors, photosensors, and manual switching.

4. Energy savings data calculated for the system as a whole.

5. Time-scaled graph showing all relay transitions.

6. Time-scaled graph showing zone occupancy time delays.

7. Time-scaled graph showing the total light level.

8. Software capable of storing information remotely onto an open-source, object-relational database, such as PostgreSQL.

9. Data stored in the database will be accessed utilizing an open standard, application programming interface, such as Open Database Connectivity (ODBC).

C. Visualization and Programming Interfaces:

1. System provides an optional web-based visualization interface that displays a graphical floorplan.

2. Graphical floorplan will offer the following types of system visualization:

      a.   Full Device Option: Master graphic of entire building, by floor, showing each control device installed with zones outlined including:

            1.   Controls embedded light fixtures.

            2.   Controls devices not embedded in light fixtures.

            3.   Daylight sensors.

            4.   Occupancy sensors.

            5.   Wall switches and dimmers.

            6.   Scene controllers.

            7.   Networked relays.

            8.   System Controllers.

            9.   Group outlines.

   a. Group-Only Option: Master graphic of the entire building, by floor, showing only control groups outlined.

   b. Pan and zoom commands supported to allow smaller areas to be displayed on a larger scale simply by panning and zooming each floor's master graphic.

   c. Selecting any control device displays the following as applicable:

    1. Device catalog number.

    2. Device name and custom label.

    3. Device diagnostic information.

    4. Link to further information on device including status or current configuration.

  3. Programming capabilities through the application will include the following:

   a. Switch, occupancy sensor, and photosensor zone configuration.

   b. Manual-on or automatic-on modes.

   c. Turn-on and dim to dimming levels.

   d. Occupancy sensor time delays and PIR sensitivity.

   e. Dual technology occupancy sensors sensitivity.

   f. Photosensor calibration adjustment and auto-setpoint.

   g. Multiple photosensor zone offset.

   h. Trim level settings.

   i. Preset scene creation and copy for scene-capable devices.

   j. Application of custom device labels to the Bluetooth Low-Energy Programming Devices and individual connected lighting control devices.

   k. Fade rate settings.

D. Smartphone Programming Interface for Wired and Wireless Devices:

  1. Interface provided for both Apple iOS and Android operating systems that allows configuration of lighting control settings.

  2. Application supports configuration of wireless networked control devices.

   a. Application access granted with valid user name and password.

   b. Access to program information governed by permission system that allows users to share access with other users and restrict access to those who should not be able to reconfigure the equipment.

   c. Indication of signal strength where multiple Bluetooth Low-Energy Programming Devices are available for configuration.

  3. Programming Capabilities:

   a. Switch, occupancy sensor, and photosensor group configuration.

   b. Manual-on or automatic-on modes.

   c. Turn-on and dim to dimming levels.

   d. Occupancy sensor time delays and PIR sensitivity.

   e. Dual technology occupancy sensors sensitivity.

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   f. Photosensor calibration adjustment and auto-setpoint.

   g. Multiple photosensor zone offset.

   h. Trim level settings.

   i. Preset scene creation.

   j. Application of custom device labels for individual connected lighting control devices.

   k. Fade rate settings.

4. SYSTEM BACKBONE AND SYSTEM INTEGRATION EQUIPMENT

A. System Controller: Multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.

  1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nECY or comparable product by one of the following:

   a. Cooper Industries, Inc.

   b. Leviton Manufacturing Co., Inc.

   c. Insert manufacturer's name.

  2. System Controller Processor: 32-bit microprocessor operating at a minimum of 1 GHz.

  3. System Controller Memory: Minimum of 512MB memory, with a minimum of 4GB non-volatile flash, to support operating system and databases.

  4. System Controller Functions:

   a. Time-based control of downstream wired and wireless network devices.

   b. Linking into an Ethernet network.

   c. Integration with Building Management Systems (BMS) and Heating, Ventilation and Air Conditioning (HVAC) equipment.

   d. Connection to various software interfaces, including management interface, historical database and analytics interface, and visualization interface.

  5. Integral web server to support system controller configuration and diagnostics with control and visualization of connected devices.

   a. Web Server Control Interface:

    1. Display associated devices within the context of a graphical floorplan.

    2. Provide control of output-capable devices through virtual sliders, toggle buttons, preset level widgets, and transparent layers on floorplan.

    3. Control Capabilities:

     a. Control of individual output devices, including control of relay state and analog dimming level where applicable.

    4. Control of local lighting control zones, including control of relay state and analog dimming level where applicable.

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a.   Visualization Interface:
1.   Customizable display with the ability to superimpose colored, transparent layers representing real-time property values, including occupancy status, dimming level status, light level status, and online or offline status where applicable.
2.   Ad hoc display of trended information via an intuitive values-over-time graph.
3.   Report Creation:
a.   Reports accept and graphically display trended status datasets for creator selected devices or zones of devices.
b.   Report information displayed over a user-defined interval and date range.
c.   Reports exportable to a standard CSV format.
6.   Graphical touch screen to support configuration and diagnostics.
7.   Minimum of three RJ-45 networked lighting control ports for connection to any of the following:
a.   Graphical touch screen.
b.   Direct connection to networked wired luminaires and intelligent lighting control devices (up to 128 total devices per port).
8.   Device will automatically detect all network-connected devices.
9.   Capable of managing and operating a minimum of 750 networked devices (wired or wireless) per system controller.
10. Multiple System Controllers capable of connection via LAN for scalability to a minimum of 20,000 networked devices.
11. Supports BACnet/IP and BACnet MS/TP protocols to directly interface with BMS and HVAC equipment without additional protocol translation gateways.
a.   BACnet MS/TP Connection Speed: 9600 to 115200 baud rate.
b.   BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.
12. Integral FIPS 140-2, Level 1 cryptographic module.
13. Supports RESTful API for control of BACnet objects, user management, date and time, and file management.
14. NEMA 1 enclosure with Class 1 and Class 2 separation.
a.   Power Supply Voltage: Specify Voltage V(ac).
15. Automatic algorithm to eliminate redundant, wireless networked paths to streamline communication between the system controller and end devices.
16. System Controller Security Provisions:
a.   Disallow the use of default passwords and require passwords to be updated prior to use.
b.   Support user role-based access, such as administrator, user, and viewer.

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      a.   Signed firmware to ensure that unmodified, authentic software is always installed.

      b.   IP-based communication protected with strong encryption algorithms such as AES or TLS1.2+.

      c.   Prevent rollback of firmware to firmware versions with known, critical vulnerabilities.

      d.   Valid cybersecurity listing through a third party.

17.   Cellular Remote Access: Cellular router and modem for remote access.

      a.   Router supports remote access to at least five system controllers on its local area network or network subnet.

      b.   Remote access capable of device setting updates, schedule updates, system performance optimization, and diagnostics.

      c.   Remote access enabled through outbound communication from router to an outside source. Solutions that begin communication via inbound requests for network access are unacceptable.

      d.   Router supports outbound communication to manufacturer-hosted portal using TLS1.2 or greater in-transit encryption over a cellular or Ethernet connection.

      e.   Router with integral firewall to prevent unauthorized access to devices connected to its local area network port.

      f.   Router includes cellular SIM capable of connection to AT&T, T-Mobile, Sprint, US Cellular, Alaska Wireless, Telefonica, Tellus, Bell, or Sasktel networks where carrier service is available.

      g.   Outbound communication from the router limited to whitelisted endpoints. Devices that allow unrestricted communication are unacceptable.

      h.   Outbound communication from router includes only lighting control system information.

6.   WIRELESS NETWORKED DEVICES

    A.   Wireless Networked Wall Switches, Dimmers:
        1.   Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rPOD series or comparable product by one of the following:
            a.   Cooper Industries, Inc.
            b.   Leviton Manufacturing Co., Inc.
            c.   Insert manufacturer's name.
        2.   Mounting: Suitable for installation in single-gang switch box.
        3.   Wireless Communication:
            a.   Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
            b.   Security: AES-128 bit.
        4.   Power Supply: Power source.
        5.   Mechanical push buttons provide tactile and LED user feedback during button press.
        6.   Mechanical push buttons available with custom button labeling.
        7.   Wall Switches and Dimmer Options:
            a.   Number of Control Zones: Control Zones.
            b.   Control Types Supported: On/Off and On/Off/Dimming.
        8.   Scene Switch Options:
            a.   Number of Scenes: Number of Scenes.
            b.   Control Types Supported: On/Off, On/Off/Dimming, and Preset Level Scene Type.
        9.   Color: Enter switch color.

    B.   Wireless Networked Embedded Fixture Control Devices:
        1.   Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rIO or comparable product by one of the following:
            a.   Cooper Industries, Inc.
             b.   Leviton Manufacturing Co., Inc.
             c.   Insert manufacturer's name.
         2.   Wireless Communication:
            a.   Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
            b.   Security: AES-128 bit.
         3.   Power Supply: Standard low-voltage wiring typically associated with an LED driver.
        4.   Suitable for installation within a luminaire such that the control device is not visible on the luminaire face.
        5.   Devices available with integrated and remote antennas such that devices can be installed within sealed container without detriment to wireless strength.

1. Antenna Color: Enter antenna color.
2. Dimming Output: Enter dimming protocol.
3. Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.

C. Wireless Networked Indoor Load Controllers with Occupancy and Photosensors:
1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rLSXR or comparable product by one of the following:
a. Cooper Industries, Inc.
b. Leviton Manufacturing Co., Inc.
c. Insert manufacturer's name.
2. Wireless Communication:
a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
b. Security: AES-128 bit.
3. Detect the presence of human activity within space and fully control the on/off function of lights.
4. Utilizes passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic and Microwave-based sensing technologies are unacceptable.
5. Dual technology sensors used in locations where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions).
6. Dual technology sensors must have one sensing technology not motion dependent to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT), which detects both occupant motion and sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) are unacceptable.
7. All sensing technologies are acoustically passive, meaning they do not transmit sound waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers and hearing devices). Acceptable detection technologies include Passive Infrared (PIR) and/or Microphonic technology. Ultrasonic and Microwave-based sensing technologies are unacceptable.
8. Sensor programming parameters available and configurable remotely.
9. Ceiling, fixture, and junction box mounted sensors available, with multiple lens options available customized for specific applications.
10. Integral daylight photosensor for programmable daylight harvesting.
11. Photosensor includes adjustable illumination set-point and dead band to prevent the artificial light from cycling. Set-point and dead band capable of automatically calibrating through an "Automatic Set-Point Programming" procedure. Min and max dimming settings

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and set-point may be manually entered or modified.

12. Dead band setting verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).

13. Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.

14. Power Monitoring: Integral current measurements on output with 3 percent accuracy when measuring loads 225 mA or greater.

D. Wireless Networked Indoor Occupancy and Photosensors:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; Enter sensor choice or comparable product by one of the following:
   a. Cooper Industries, Inc.
   b. Leviton Manufacturing Co., Inc.
   c. Insert manufacturer's name.

2. Wireless Communication:
   a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
   b. Security: AES-128 bit.

3. Detect the presence of human activity within space and fully control the on/off function of lights.

4. Utilizes passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic and Microwave-based sensing technologies are unacceptable.

5. Dual technology sensors used in locations where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions).

6. Dual technology sensors must have one sensing technology not motion dependent to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT), which detects both occupant motion and sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) are unacceptable.

7. All sensing technologies acoustically passive, meaning they do not transmit sound waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers and hearing devices). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonic technology. Ultrasonic and Microwave-based sensing technologies are unacceptable.

8. Sensor programming parameters available and configurable remotely.

9. Ceiling, fixture, and junction box mounted sensors available, with multiple lens options available customized for specific applications.

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1. Dry Contact Output: One integrated dry contact switching relay, capable of switching 100 mA at 24 V, resistive only.
2. Integral daylight photosensor for programmable daylight harvesting.
3. Photosensor includes adjustable illumination set-point and dead band to prevent the artificial light from cycling. Set-point and dead band capable of automatically calibrating through an "Automatic Set-Point Programming" procedure. Min and max dimming settings and set-point may be manually entered or modified.
4. Dead band setting verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).

E. Wireless Networked Outdoor Occupancy and Photosensors:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rSBOR or comparable product by one of the following:
      a. Cooper Industries, Inc.
      b. Leviton Manufacturing Co., Inc.
      c. Insert manufacturer's name.
   2. Wireless Communication:
      a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
      b. Security: AES-128 bit.
   3. Mounting: Enter required mounting.
   4. Supply Voltage: Enter voltage V(ac).
   5. Detect the presence of human activity within space and fully control the on/off function of lights.
   6. Utilizes passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic and Microwave-based sensing technologies are unacceptable.
   7. Sensors detect valid communication and blink a unique LED pattern to visually indicate a potential issue.
   8. Sensor programming parameters available and configurable remotely.
   9. Available with multiple lens options available for various mounting heights.
   10. Power Monitoring: Integral current measurements on output with 3 percent accuracy when measuring loads 225 mA or greater.
   11. Integral daylight photosensor for programmable daylight harvesting.
   12. Photosensor includes adjustable illumination set-point and dead band to prevent the artificial light from cycling. Set-point and dead band capable of automatically calibrating through an "Automatic Set-Point Programming" procedure. Min and max dimming settings and set-point may be manually entered or modified.
   13. Dead band setting verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).

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1. Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.

F. Wireless Networked Indoor Embedded Sensors:
1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; Enter sensor choice or comparable product by one of the following:
   a. Cooper Industries, Inc.
   b. Leviton Manufacturing Co., Inc.
   c. Insert manufacturer's name.
2. Wireless Communication:
   a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
   b. Security: AES-128 bit.
3. Sensors consisting of occupancy sensors and dimming photosensor suitable for installation within a luminaire such that only the lens is visible on luminaire face.
4. Power Supply: Standard low-voltage wiring typically associated with an LED driver.
5. Devices available with integrated and remote antennas such that devices can be installed within sealed container without detriment to wireless strength.
6. Antenna Color: Enter antenna color.
7. Dimming Output: Enter dimming protocol.
8. Detect the presence of human activity within space and fully control the on/off function of lights.
9. Utilizes passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic and Microwave-based sensing technologies are unacceptable.
10. Sensors detect valid communication and blink a unique LED pattern to visually indicate a potential issue.
11. Sensor programming parameters available and configurable remotely.
12. Available with multiple lens options available for various mounting heights.
13. Integral daylight photosensor for programmable daylight harvesting.
14. Photosensor includes adjustable illumination set-point and dead band to prevent artificial light from cycling. Set-point and dead band capable of automatically calibrating through an "Automatic Set-Point Programming" procedure. Min and max dimming settings and set-point may be manually entered or modified.
15. Dead band setting verified and modified by sensor automatically every time lights cycle to accommodate physical changes in space (i.e., furniture layouts, lamp depreciation, or lamp outages).
16. Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.

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G.   Wireless Networked Outdoor Embedded Sensors:

1.   Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; Enter Sensor Choice or comparable product by one of the following:

    a.   Cooper Industries, Inc.

    b.   Leviton Manufacturing Co., Inc.

    c.   Insert manufacturer's name.

2.   Wireless Communication:

    a.   Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.

    b.   Security: AES-128 bit.

3.   Sensors consisting of occupancy sensors and dimming photosensor suitable for installation within a luminaire such that only the lens is visible on luminaire face.

4.   Power Supply: Standard low-voltage wiring typically associated with an LED driver.

5.   Color: Enter color.

6.   Ingress Protection: Minimum IP66.

7.   Devices available with remote antennas such that devices can be installed within sealed container without detriment to wireless strength.

8.   Detect the presence of human activity within space and fully control the on/off function of lights.

9.   Utilizes passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic and Microwave-based sensing technologies are unacceptable.

10.   Sensors detect valid communication and blink a unique LED pattern to visually indicate a potential issue.

11.   Sensor programming parameters available and configurable remotely.

12.   Available with multiple lens options available for various mounting heights.

13.   Integral daylight photosensor for programmable daylight harvesting.

14.   Photosensor includes adjustable illumination set-point and dead band to prevent artificial light from cycling. Set-point and dead band capable of automatically calibrating through an "Automatic Set-Point Programming" procedure. Min and max dimming settings and set-point may be manually entered or modified.

15.   Dead band setting verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).

16.   Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.

H.   Wireless Networked Power Packs:

1.   Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rPP series or comparable product by one of the following:

       a.   Cooper Industries, Inc.

       b.   Leviton Manufacturing Co., Inc.

       c.   Insert manufacturer's name.

2.   Wireless Communication:

       a.   Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.

       b.   Security: AES-128 bit.

3.   Plenum rated.

4.   Supply Voltage: Enter voltage V(ac).

5.   Relay Output: Class 1 relay rated for 20 A and 1.5 HP at 120 to 277 V(ac) and 5 A and 0.5 HP at 480 V(ac).

6.   Dimming Output: 0-10 V(dc).

7.   Sink Current: 150 mA at 0-10 V(dc).

8.   Antenna Type: Antenna.

9.   Programming parameters available and configurable remotely.

10.   Mounting: Integral 1/2-inch (16-mm) chase nipple. Plastic clips into junction box are unacceptable.

11.   Power Packs Options:

       a.   Power Pack capable of full 20-Amp switching of all normal power lighting load types, with optional 0-10V dimming output capable of up to 150 mA of sink current.

       b.   Power Packs capable of full 20-Amp switching of general purpose receptacle (plug-load) control.

       c.   Listing: UL 924 for control of emergency lighting circuits, field configurable for two distinct sequence of operation:

           1.   Power sense of normal power feed, where unit powers and controls emergency circuit, and loss of the normal power sense circuit forces the power pack to shunt closed, go to full bright, and ignore all system commands until normal power is restored.

           2.   Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.

       d.   Power Monitoring: Integral current measurements on output with 3 percent accuracy when measuring loads Enter current mA or greater.

       e.   Chicago Plenum External Antenna:

           1.   Mounting: 1/2-inch (16-mm).

           2.   Ingress Protection: IP67.

I.   Wireless Networked Communication Adapter:

1.   Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nECYD or comparable product by one of the following:

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       a.   Cooper Industries, Inc.

       b.   Leviton Manufacturing Co., Inc.

       c.   Insert manufacturer's name.

2.   Wireless Communication:

       a.   Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.

       b.   Security: AES-128 bit.

3.   Capable of supporting a minimum of 750 networked wireless devices per adapter.

4.   Interface: USB connection.

5.   Ingress Protection: Minimum IP66.

6.   Mounting: Integral 1/2-inch (16-mm) chase nipple. Minimum 16 ft. (4.8 m) USB cable and optional cable extenders for remote mounting.

PART THREE - EXECUTION

1.   INSTALLATION OF WIRING

A.   Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260523 "Control-Voltage Electrical Power Cables." Minimum conduit size is 1/2 inch (13 mm).

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

    2.   Comply with requirements for raceways and boxes specified in Section 260533.13 "Conduits for Electrical Systems," and Section 260533.16 "Boxes and Covers for Electrical Systems,"

B.   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.

2.   IDENTIFICATION

A.   Identify system components, wiring, cabling, boxes, cabinets, and terminals. Comply with identification requirements specified in Section 260553 "Identification for Electrical Systems."

B.   Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with Section 260553 "Identification for Electrical Systems."

C.   Identify all controls with device address.

D.   Label each device cable within 6 inch (152 mm) of connection to bus power supply or termination block.

3.   FIELD QUALITY CONTROL

A.   Acceptance Testing Preparation:
    1.   Test continuity of each circuit.

B.   Field tests and inspections must be witnessed by Enter witnesses.

C.   Tests and Inspections: Enter responsible party test inspections.
    1.   Test each zone using local and remote control hardware.
    2.   Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.

D.   Nonconforming Work:
    1.   Lighting controls will be considered defective if they do not pass tests and inspections.
    2.   Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

E.   Field Test Reports: Enter responsible party field test reports.
    1.   Prepare functionality and inspection reports, including a certified report that identifies controls included and describes test results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.
    2.   Include list of all points created from actual tests of all addressed control points for lamps, ballasts, manual controls, and sensors.

4.   REMOTE ACCESS

A.   Digital network lighting control system capable of remote access by manufacturer with the following features:
    1.   System diagnostics including detection of fault condition in hardware or connected devices.
    2.   Access to all connected devices for complete programming including scheduling of time-of-day events and device parameters necessary to meet required sequence of operations.
    3.   Browser-based interface to verify system functionality.
    4.   On-demand access to manufacturer technical support for remote troubleshooting, diagnostics, configuration, and programming.
    5.   Owner training on the digital network lighting control system available remotely.

B.   Remote access system fully functional over commercial cellular connection or Internet-connected ethernet network.

C.   All hardware associated with remote access including cellular modem and cellular antenna are to remain on-site regardless of warranty or cellular contract status.

5.   SYSTEM STARTUP

 A.   Enter responsible party startup service.

  1.   Complete installation and startup checks in accordance with manufacturer's published instructions.
  2.   Activate luminaires and verify that all maximum output levels match output levels detailed in an Owner-approved sequence of operations.
  3.   Confirm correct communications wiring, initiate communications between control devices and controller/gateways, and program the lighting control system in accordance with approved configuration schedules, time-of-day schedules, and input override assignments.
  4.   Program network devices to meet required sequence of operations.
  5.   Program and verify all sequence of operations.
  6.   Create backup of system programming.
  7.   Assist in installation of system software on customer-provided workstation or server.
  8.   Verify bidirectional communication of manufacturer-provided cellular router with manufacturer-managed remote access portal.
  9.   Insert startup steps if any.
  10.   Commissioning Walkthrough: Enter responsible party to demonstrate lighting control system functionality and verify the system meets the specified Project requirements.

6.   CLOSEOUT ACTIVITIES

 A.   Enhanced Documentation: Engage lighting system manufacturer to provide comprehensive system documentation including detailed programming, sequence of operation data per Project specifications, and related code requirements.
 B.   Training: Engage lighting system manufacturer to provide comprehensive system overview, software overview, and documentation relating to system operation and maintenance.

7.   PROTECTION

 A.   After installation, protect digital network lighting controls from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

8.   MAINTENANCE

 A.   Engage a factory-authorized service representative to perform on-site system adjustments.

  1.   On-Site Occupancy Adjustments: When requested within Insert number months from date of Substantial Completion, provide on-site settings adjustments to suit actual occupied conditions. Provide up to Insert number visits to Project during other-than-normal occupancy hours for this purpose.

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   2.   Prepare and submit report after each visit that details activities performed.

A.   Engage a factory-authorized service representative to perform remote system adjustments.
   1.   Remote Occupancy Adjustments: When requested within Insert number months from date of Substantial Completion and project registration with lighting control system manufacturer, provide remote settings adjustments to suit actual occupied conditions. Provide up to Insert number sessions to Project during other-than-normal occupancy hours for this purpose.
      a.   System to include manufacturer-provided cellular communication hardware and connection to the system for a minimum of Insert number months after substantial completion to allow for factory representative assistance with settings adjustments and system sustainment.
      b.   For the remaining duration of the maintenance term, or in the event cellular connectivity is not available, manufacturer assistance must be available through an Owner-provided, Internet-connected network.
   2.   Prepare and submit report after each session that details activities performed.

B.   Maintenance Service Agreement:
   1.   Beginning at Substantial Completion, verify that maintenance service agreement includes 12 months' full maintenance by manufacturer's authorized service representative.
   2.   Include Enter frequency Enter location preventive maintenance.
   3.   Preventative maintenance to include:
      a.   System diagnostic reports.
      b.   System performance checks.
      c.   Device firmware updates.
      d.   Programming adjustment as required for proper lighting system operation.
      e.   Expedited factory direct warranty processing, replacement, and programming of defective components.
   4.   Verify that parts and supplies are manufacturer's authorized replacement parts and supplies .

END OF SECTION 260943.19