

Section _____
ILC LIGHTLEEDER
LIGHTING CONTROL SYSTEM

PART 1 – GENERAL

1.1 SUMMARY

- A.** The intent of this set of specifications is to provide a complete, functional, intelligent, low-voltage lighting control system for the control of incandescent, low-voltage, LED, neon, cold cathode, fluorescent, and HID lighting sources.
- B.** Where shown in the drawings, the contractor shall furnish and install a complete low-voltage lighting control system consisting of, but not limited to, relays, contactors, controllers, enclosures, switch stations and miscellaneous components as required for a complete, operational lighting control system.
- C.** Where applicable standards have been established, all items of equipment, individual components, and installation methods shall meet the requirements of these standards, including, but not limited to, Underwriter Laboratories, the National Electrical Code, Federal Communications Commission, and any local or state codes that may be applicable.
- D.** The products specified herein are those of Intelligent Lighting Controls, Inc. Low voltage lighting control systems manufactured by the following manufactures shall be considered providing they meet the requirements of these specifications and provide the quality and performance specified herein.
 - 1.** Intelligent Lighting Controls, Inc.
 - 2.**
 - 3.**
- E.** Listing of a manufacturer as acceptable does not in any way relieve the contractor from the responsibility for providing a lighting control system that meets all the requirements of these specifications.
- F.** All manufacturers shall submit to the specifying engineer a line-by-line compliance comparison between each specification requirement and the system being proposed.
- G.** Any ambiguities in the drawing or specification shall be brought to the attention of the specifying engineer for clarification.

1.2 QUALITY ASSURANCE

- A. Factory Assembly:** All relays, contactors, controllers, enclosures, switch stations and miscellaneous components shall be factory assembled and tested. All system components shall arrive at the job site completely pre-wired and ready for installation, requiring only the connection of lighting circuits and low-voltage control stations and/or network terminations. All connections shall be made to clearly and permanently labeled termination points. Systems that require field assembly shall not be acceptable.
- B. Manufacturer:** A minimum of 20 years' experience in the design and manufacture of lighting control equipment.
- C. Component Testing:** All system components and assemblies shall be individually tested prior to assembly. Once assembled, all finished products shall be tested for proper operation of all control functions per specifications prior to shipment.
- D. NEC Compliance:** All system components shall comply with all applicable sections of the National Electrical Code (NEC) as required.
- E. NEMA Compliance:** All system components shall comply with all applicable portions of NEMA standards pertaining to types of electrical equipment and enclosures.
- F. UL Approval:** All applicable equipment shall be UL listed under section 916 and shall bear labels indicating compliance.
- G. FCC Emissions:** All applicable equipment shall comply with FCC emissions standards specified in Part 15 and Part 68 where applicable, for commercial applications and shall bear labels indicating compliance testing. Equipment that does not meet these standards shall not be acceptable.

1.3 SUBMITTALS

- A. The manufacturer shall provide an electronic copy of submittal drawings and data for approval prior to beginning manufacture of equipment.
- B. Hard copy submittal package shall be provided upon request.
- C. Submittal package shall include, but not be limited to, the following. Submittals that do not contain all the information listed below will not be considered for approval.
 - 1. **Specifications Compliance:** Submit a line-by-line comparison that describes the differences between each specifications requirement and the equipment/systems being proposed. The comparison shall include a complete listing of how the proposed equipment/systems differ from that specified with regard to size, quantity, quality, a method of control, features and functions, control software functions and installation requirements.
 - 2. **System Description:** Supply as part of the submittal package a brief description of the lighting control system's major features and functions.
 - 3. **Bill of Materials:** Provide as part of the submittal package a detailed itemized listing of all proposed equipment, including quantities and capacities for all major system components.
 - 4. **Product Data Sheets:** Provide as part of the submittal package detailed product data sheets for all major system components.
 - 5. **Riser Drawing:** Provide as part of the submittal package a system riser drawing of sufficient detail to indicate the relative placement of major system components and the required connections between each. Drawings shall be project specific. Generic or typical riser diagrams shall not be acceptable.
 - 6. **Control Schedules:** Provide as part of the submittal package a complete control schedule spreadsheet for relay panels, Timers, Inputs, Groups, and Presets.
 - 7. **Switch Details:** Provide as part of the submittal package complete switch details including color, gangs, buttons, plate style, plate colors, and engraving.
 - 8. **Warranty:** Provide as part of the submittal package a complete written warranty.

1.4 WARRANTY

- A. Manufacturer's Warranty:** Manufacturer shall provide a written warranty that shall cover all lighting control equipment. The manufacturer shall agree to repair or replace any equipment that fails due to material or workmanship for a period of 6 years.
- B. Relay Warranty:** Manufacturer shall provide a separate written warranty that shall cover all lighting control relays within the lighting control system. The manufacturer shall agree to replace any relay that fails due to material or workmanship for a period of 6 years.
- C. Warranty Period:** The warranty period shall begin after the completion of the installation and the systems field-start-up and training. Systems not provided with a field-start-up begins upon receiving of the product.

PART 2 – PRODUCTS

2.1 LIGHTLEEDER PROGRAMMABLE LIGHTING CONTROL PANELS

A. Hardware Features:

1. **Controller Back-Box:** Each programmable lighting controller shall be provided with a factory furnished; UL listed NEMA 1 enclosure designed for wall mounting. Backbox must be capable of being shipped ahead of controller chassis insert to allow for rough-in of all electrical connections prior to receipt of the controller chassis insert.
2. **Controller Chassis Insert:** Each programmable lighting controller shall be provided with a factory or field installable controller chassis insert. Controller chassis insert shall contain all controller electronics, power supplies, relays, contactors and other required components. Controller chassis inserts shall arrive at the project site completely pre-wired and require only the connection of lighting circuits and control devices.
3. **Line Voltage / Control Voltage Separation:** Each programmable lighting controller shall be provided with a mechanical barrier that separates all line voltage components and wiring from all control voltage components and wiring. An additional barrier may be installed within the line voltage section that shall provide isolation between normal and emergency circuits where required.
4. **Controller Covers:** Each programmable lighting controller shall be provided with a dead front screw-held or hinged locking cover that is designed for either surface or flush mounting. If a hinge locking door is provided, it shall be provided with a slam-latch with 2 keys and door hooks to assist in mounting.
5. **Controller Capacity/Configurations:** Controllers shall be available in sizes to accommodate 4, 8, 16, 24, 32, 40, 48, 56, and 64 relay outputs. Controllers shall be available with the electronics in the center and voltage dividers with the lighting relays on the right and left sides.

B. Electrical:

1. **Controller Power Supply:** Each programmable lighting controller shall be provided with a dual-rated, UL listed Class 2 transformer capable of either 120/277 VAC or 120/347 VAC primary (50 to 60 Hz). It shall contain an internal self-resetting fuse.
2. **Connections:** All connections shall be made to clearly and permanently labeled termination points.

C. Controller Electronics:

1. **Controller CPU:** Each programmable controller shall be provided with a CPU (Central Processing Unit) that shall provide all the programming and control functions for the entire controller.
2. **Real-Time Clock:** Each controller shall be provided with a Real-Time Clock used to perform all time-controlled functions. It shall use a high voltage line-sync circuit for timing and a crystal for backup. Clock accuracy shall be held +/- 2 minutes per year and displayed to the second with the line-sync setting. Real-Time Clock functions shall include time of day, day of week, date and automatic daylight saving time and leap year adjustments. Time clock shall be protected against loss of time during a power outage for a period of up to 45 days without power of any type. Daylight Saving Time shall be adjustable with an enable/disable feature. Systems relying on a single clock device shall not be acceptable.
3. **Relay Driver Module:** Relay output cards shall be provided to expand the controller capability from 8 to 64 relay outputs in increments of 8. Electronics shall feature surge protection and optic-isolation. It shall also provide an interface for mounting input boards.
4. **Relay Control Switches:** Controller shall contain push-button switches to turn all relays ON or OFF without the presence of any programming.
5. **Backup and Restore:** The controller shall be equipped with an internal memory backup and restore capability. It shall have the ability to backup all internal programming into additional onboard memory, verify present programming with backup, and restore programming.
6. **Runtime Logging:** The controller shall be equipped with memory to log the runtime of each relay. It shall be capable of storing up to 30 days or 1092 hours of data and be able to be exported in a delimitative format.
7. **Non-Volatile Memory:** Controller shall contain a minimum of 4 Mb of nonvolatile EEPROM memory with a data retention of >200 years and electrostatic discharge protection of >4000V.
8. **Power Input Surge Suppression:** The controller's 24VAC power input shall be equipped with double surge suppression to protect the electronics from transient over-voltages. Protection shall clamp over-voltages up to 123 volts.

9. **Data Line Surge Suppression:** The controller data line communications shall be equipped with transient voltage suppression protection that will protect the electronics from electrostatic discharge and other transient over-voltages. Protection shall clamp transients up to 8kv direct discharges and 15kv air discharges.
10. **Data Line Communications:** The controller shall be equipped with serial communications through RJ45 connectors for communicating on CAT-5 cable with other panels and LightSync devices. It shall also be equipped with a separate local port for communicating with LightSync devices. The communications shall consist of 2-RS485 data lines.
11. **USB Serial Communications:** A USB port shall be provided for programming and interfacing the system with the use of a personal computer.
12. **TCP/IP Communications:** A TCP/IP port shall be provided for programming and interfacing the system with a personal computer over a network (LAN) or the internet (WAN).
13. **Optional Module Interface:** The controller shall contain 4 ports for interfacing optional modules which include communications and power. Optional modules shall be able to be mixed on each controller.

D. Switching and Control Devices:

1. **Device Node Capacity:** The lighting controller shall support switch input control of up to 64 data line LightSync devices locally per panel and 254 per network for up to 16,510 devices. The first 8 device nodes shall be powered by the lighting controller. The addition of a power supply or power supply/repeater shall be required for each additional 20 device nodes. Each LightSync device shall have a unique address and shall be capable of being programmed to the applicable functions described in the Switched Input Types heading in this specification.
2. **Data Line Media:** The data line shall consist of RS485 communications protocol transmitted over CAT-5, CAT-5E, or CAT-6 Cable. The cable shall have male RJ45 connectors installed on each end for interfacing controllers and LightSync devices. Both daisy chain and “T” (3 direction branching) of cable runs shall be permitted. “T” branching shall be accomplished by the addition of power supply/repeaters. It shall be able to be wired in a home run configuration for LightSync devices by the addition of a LightSync Hub.

3. **LightSync Switch Stations:** LightSync data line switch stations shall be available in momentary push button (1-6 switches and pilots) and each switch shall have an associated pilot light. Each button shall control any or all of the relays in the lighting controllers or the dimmer outputs on the network. There shall be an option to program each pilot LED to indicate the state of any relay, Group, Preset, and static on or off. It shall also have the capability to reverse the status: LED is ON if the relay is OFF etc.
4. **LightSync Photocell Controllers:** The photo controller shall be provided with 256 light to dark levels (0-1800fc). It shall allow selection of 8 individual set points for OFF and ON and includes a selectable range of dead-band. It shall be programmable for 2 or 30 seconds delay. Each set point shall control any or all of the relays in the lighting controllers or the dimmer outputs on the network.
5. **LightSync Input Modules:** The input module shall provide 4 inputs that accept momentary, momentary PB and maintained switch closures. Each input shall be optically isolated and have the ability to accept dry contact closures or 12-24VDC signals. Each input shall control any or all of the relays in the lighting controllers or the dimmer outputs on the network. It shall provide four pilot outputs that provide the true status of relays, groups and presets. It shall be installed in the control panel or remote mounted.
6. **LightSync Disable Key Switch:** The disable switch shall provide an RJ45 connector that shall disable all LightSync devices down line with the closure of a key switch. It shall also provide two RJ45 connectors to pass data through. It shall indicate with an LED when the disable switch is active.
7. **LightSync Occupancy Sensor Input Module:** The occupancy sensor input module shall provide power and inputs for motion sensors. It shall have 4 or 8 independent inputs that shall be able to interface multiple sensors. Each input shall control any or all of the relays in the lighting controllers or the dimmer outputs on the network. It shall be installed in the control panel or remote mounted.
8. **LightSync 0-10V Dimmer Output Module:** The 0-10VDC dimmer output module shall be designed to control dimmable ballasts or other 0-10VDC devices. Each module shall have 4 independent output channels that can control up to 200 devices per output at .5mA per device. It shall have the capability to vary its level 256 steps between 0 and 10VDC. It shall be able to respond to photo controllers, switch inputs, DMX512 signals, and timers. Each output shall be galvanically isolated up to 1500V to protect electronics. It shall be installed in the control panel or remote mounted.

- 9. LightSync Motor Control Output Module:** The motor control output module shall be designed to control shade motors, louver motors, blind motors, skylights, or any other class 2 DC motors. Each module shall have 4 independent outputs that can be controlled by a switch input, photocell, or timer. The control time shall be selectable from .1 to 300 seconds. Each lighting controller shall handle up to 8 modules with 4 outputs on each. Each output shall be equipped with a limit switch input for each direction of the motor.
 - 10. Graphical Touch Screen Control Station:** The Touch screen control station shall display the status and control the lighting control panel relay outputs via pre-programmed control objects on standard or custom bitmap screens.
- E. Special Purpose Modules:** The following special purpose controller nodes shall be available. Multiple modules shall be permitted per controller.
- 1. BACnet Control:** This module shall communicate directly to the lighting controller through serial communications from the BAS system using BACnet MSTP or BACnet IP protocol. It shall be able to read the status of inputs and relays and control single or multiple relays in the lighting controller. It shall also be able to disable/enable inputs and shall be able to force timer options.
 - 2. DMX Control:** This module shall support the control of relays using standard USITT DMX512 protocol used by theatrical lighting systems. Each relay in the lighting panel shall be configured to be controlled by any DMX channel. It shall contain a frame filter that can be set from 1 – 16 frames. It shall have a priority setting for switch inputs or DMX signals. It shall have the capability to control any 0 – 10V dimming output throughout the network. It shall display current DMX levels from the keypad.
 - 3. DMX Driver:** This module shall send DMX signals from the lighting control panels using standard USITT DMX512 protocol used by theatrical lighting systems. Each module added to the panel shall control up to 64 channels. Each dimming output channel shall be able to be mapped to 1-512 DMX channels. It shall be 1 to 1 mapped or programmed with free software. It shall be installed in the control panel or remote mounted.
 - 4. Modbus Control:** This module shall communicate directly to the lighting controller through RS485, RS232, or TCP serial communications from the BAS system using Modicon Modbus RTU or ASCII protocol. It shall be able to read the status of inputs and relays and control single or multiple relays in the lighting controller. It shall also be able to disable/enable inputs and shall be able to force timer options.

5. **N2 Control:** This module shall communicate directly to the lighting controller through serial communications from the BAS system using Metasys-N2 protocol. It shall be able to read the status of inputs and relays and control single or multiple relays in the lighting controller. It shall also be able to disable/enable inputs and shall be able to force timer options.
 6. **LonWorks Control:** This module shall communicate directly to the lighting controller through serial communications from the LonWorks network. It shall be able to read the status of inputs and relays and control single or multiple relays in the lighting controller. It shall also be able to disable/enable inputs and shall be able to force timer options.
 7. **Modem Control:** This module shall allow communications over an analog telephone line to provide programming and status of the lighting control panel.
 8. **Protocol Input Control:** This module shall allow serial communications from a Modbus, N2, BACnet, or LonWorks network. It shall be capable of emulating LightSync switches or photocells for direct control and status of relays, dimmers or motor controls.
 9. **DTMF Telephone Control:** This module shall support Input Status, Relay Status and Control, Preset Control and Group Control in the lighting panel via voice prompted commands and DTMF signals from a touch-tone telephone.
- F. Programming:** Programmable controllers shall be capable of being programmed, monitored, backed-up, or controlled through any of the below methods. All programming changes shall take effect immediately as they are programmed and shall not suspend or disable switches or other system functions. The same functions shall be available for any of the connection types.
1. **Local Keypad and Display:** The system user shall be able to program, monitor and control any of the controller features and functions through the use of simple menu-driven self-prompting user interface consisting of a 4-line 20-character backlit LCD display and 8 selection keys that change function based on the current operating mode.
 2. **USB Serial Direct Connect:** The system user shall be able to program, monitor or control any of the controller features and functions utilizing LightLEEDer Pro Windows-based graphical user interface software using a USB port from a PC.
 3. **Modem Connect:** The system user shall be able to remotely program, monitor or control any of the controller features and functions utilizing LightLEEDer Pro Windows-based graphical user interface software using a PC/modem on an analog phone line.

4. **TCP/IP Connect:** The system user shall be able to remotely program, monitor or control any of the controller features and functions utilizing LightLEEDer Pro Windows-based graphical user interface software using a PC with TCP/IP on a LAN or WAN.

G. Diagnostics: Programmable controllers shall have the ability to do the following diagnostics.

1. **Power Status:** Each programmable lighting controller shall be provided with an LED on the controller and each output board that shall indicate that power is present.
2. **Keypad:** System users shall be able to view thru the keypad the current status of any relay, input, group, or preset and force any ON or OFF.
3. **Software:** System users shall be able to view thru the LightLEEDer Pro software the current status of any relay, input, group, or preset and force any ON or OFF. It shall also have the ability to scan the network for devices and controllers and then poll them to verify network quality.
4. **Relay Cycle Test:** The controller shall have a cycle test for relays to turn them off/on/off and then return them to the original state to verify proper operation. It shall display the results for each relay for turning the relay ON and OFF.
5. **Device Finder:** It shall have the capability through the keypad to find LightSync devices, dimmer devices, and motor devices on the network.
6. **Switch Test Mode:** It shall be able to enter a switch test mode, where a switch input status LED will light when switch inputs are activated. It shall disable normal control when in this mode.
7. **Demo Clock:** It shall have the ability to speed the clock's time by 10, 30, or 60 times for testing timer functions.

- H. Power Failure and Power-Up:** Each programmable lighting controller shall be provided with circuitry that shall automatically shut down the controller whenever the incoming power fails to be delivered to the controller within required limits. When power is returned to the controller, one of the following power-up modes will be implemented for each controlled relay output in the system.
1. **No Action:** Upon restoration of incoming control power, the controller electronics shall be restarted and resume normal operations and all circuits will be maintained in the condition they were last in.
 2. **Turn ON:** Controller shall turn the selected relay output to the ON state after power-up.
 3. **Turn ON if Input Closed:** Controller shall turn the selected relay output to the ON state after power-up if local input selected is closed. It shall be able to select any input to monitor.
 4. **Turn OFF:** Controller shall turn the selected relay output to the OFF state after power-up.
 5. **Turn OFF if Input Closed:** Controller shall turn the selected relay output to the OFF state after power-up if local input selected is closed. It shall be able to select any input to monitor.
 6. **On if Open Time, OFF if Closed Time:** Controller shall turn the selected relay output to the ON state during Open hours and shall turn selected relay outputs to the OFF state during Closed hours. This shall be used in conjunction with OPEN/CLOSED timers.
 7. **OFF if Open Time, ON if Closed Time:** Controller shall turn the selected relay output to the OFF state during Open hours and shall turn selected relay outputs to the ON state during Closed hours. This shall be used in conjunction with OPEN/CLOSED timers.
 8. **Time of Day:** Controller shall turn the selected relay output to the ON or OFF state based on the time of day in 30-minute increments for every day of the week.
- I. True Relay Status Feedback:** Each controller shall be provided with circuitry that shall monitor the actual current status of each relay via a set of pilot contacts mechanically linked to the relay main contacts.

J. Switch Input Details: All switch inputs shall have the following options:

1. **Input Flexibility:** Each switch input shall accept a 2 or 3 wire maintained or momentary switch. It shall be capable of accepting a dry contact, open collector closure, or a 12-24VDC signal. Each switch shall be able to have 2 switch types associated with it in an A/B form.
2. **Input to Output Programmability:** Any switch input shall be programmed to control any or all of the controller's relay outputs without limitations in the network.
3. **Input Logic Conditionals:** All switch inputs shall have 2 conditionals that add a logic "AND" or "OR" dependent on a relay on, a relay off, an "on" input opened or closed, and an "off" input opened or closed. It shall also have a priority level setting.
4. **Input Active Times:** All switch inputs shall have a time-of-day or open/close time of action. This shall change the switch type on the time of day for every 30 minutes or change per open/closed times.
5. **Input Types:**
 - a) **Momentary ON/OFF:** When momentary contact is made between the ON and COM, relay outputs controlled by this input shall be turned ON. When momentary contact is made between OFF and COM, relay outputs controlled by this input shall be turned OFF.
 - b) **Momentary ON/OFF w/Blink:** When momentary contact is made between the ON and COM, relay outputs controlled by this input shall be turned ON. When momentary contact is made between OFF and COM, relay outputs controlled by this input shall blink and postpone being turned OFF. The alert time shall be programmable from 2 to 99 minutes. The blink alert function shall blink each relay twice prior to turning OFF. If an ON command is received during the blink alert time, relay output shall be overridden and left ON for the override time. Override times shall be adjustable from 5 to 999 minutes in 1-minute increments.
 - c) **Momentary Push-Button ON/OFF:** When momentary contact is made between the ON and COM, relay outputs controlled by this input are turned ON and OFF alternately, based on current state, each time contact is made.
 - d) **Momentary Push-Button ON:** When momentary contact is made between the ON and COM, relay outputs controlled by this input shall be turned ON.
 - e) **Momentary Push-Button OFF:** When momentary contact is made between ON and COM, relay outputs controlled by this input shall be turned OFF.

- f) **Momentary Push-Button Toggle:** When momentary contact is made between ON and COM, relay outputs controlled by this input shall toggle from the present state.
- g) **Maintained ON/OFF:** When contact is made between the ON and COM, relay outputs controlled by this input are turned ON. When contact is broken between ON and COM, relay outputs controlled by this input are turned OFF.
- h) **Maintained Multi-way:** When contact is either made or broken between the ON and COM, relay outputs controlled by this input will be toggled between ON and OFF conditions. This function shall be similar to that of standard 3 and 4-way switches.
- i) **Maintained ON/OFF w/Blink:** When contact is made between the ON and COM, relay outputs controlled by this input are turned ON. When contact is broken between ON and COM, relay outputs controlled by this input shall blink and postpone being turned OFF. The alert time shall be programmable from 2 to 99 minutes. The blink alert function shall blink each relay twice prior to turning OFF. If an ON command is received during the blink alert time, relay output shall be overridden and left ON for the override time. Override times shall be adjustable from 5 to 999 minutes in 1-minute increments.
- j) **Timed ON:** The timed-ON input shall operate either from the input closure or open. If programmed to operate from the closure, the relays turn ON when the input closes and turn OFF after the time duration. The relays do nothing when the input opens. If programmed to operate from the open, the relays turn ON when the input closes and remain ON. When the input opens, the relays turn OFF after the timed-ON duration.
- k) **HID Bi-Level:** This feature requires the configuration of ON/OFF relay outputs and HI/LOW relay outputs. The first momentary contact between ON and COM sets the ON relay outputs to ON and the HI/LOW outputs to HI (for at least 15 Minutes). The second contact switches the HI/LOW outputs to LOW. Additional contact closures will toggle the HI/LOW relay outputs. The cycle then repeats until momentary contact is made between switch input OFF and COM. then the ON/OFF outputs and HI/LOW outputs are turned OFF.

- l) **Two-Step Alternating Sequence:** The first time the switch is activated, relay outputs programmed as “Group A” are turned ON and relay outputs programmed as “Group B” are turned OFF. The second time the switch is activated, “Group A” relay outputs are turned OFF and “Group B” relay outputs are turned ON. The third time the switch is activated, the pattern begins again at step one.
- m) **Four-Step Alternating Sequence:** The first time the switch is activated, relay outputs programmed as “Group A” are turned ON and relay outputs programmed as “Group B” are turned OFF. The second time the switch is activated, “Group A” relay outputs are turned OFF and “Group B” relay outputs are turned ON. The third time the switch is activated; both “Group A” and “Group B” relay outputs are turned ON. The fourth time the switch is activated; both “Group A” and “Group B” relays are turned OFF. The fifth time the switch is activated, the process begins again at step one.
- n) **Set Preset:** When momentary contact is made between the ON and COM, the selected preset scene will be activated.
- o) **Force Timer:** When momentary contact is made between the ON and COM, the selected timer will be activated.

K. Timer Functions: Each of the programmable lighting controllers shall have the described timer options listed below for the relay outputs.

1. **Time of Day Timers:** Each programmable lighting controller shall be provided with a minimum of 128 available timers (scheduled events) for use in developing time-of-day automated schedules. Each timer shall have the ability to turn any or all relay outputs ON or OFF at any time in 1-minute increments. Timers shall be day-of-week selectable and may be programmed to activate on any combination of days of the week. Each shall be capable of being programmed to be enabled or disabled for any day of the calendar year.
2. **Astronomical Scheduling:** Each controller shall contain an astronomical time clock that shall calculate sunrise and sunset times based on the geographical latitude and longitude positioning. Sunrise and sunset times may be used as activation times for any system timer. In addition to sunrise and sunset time activation, the control shall be capable of programming activation time before and after these times based on an offset of 1-999 minutes.

3. **Open/Closed Time Control:** The user shall also have the option of controlling relay outputs in relation to the Open/Closed times of the facility. The Open/Closed times may vary for different days of the week and may be programmed for each day of the year. In addition to Open/Closed time activation, the control shall be capable of programming activation time before and after these Open/Closed times based on an offset of 1-999.
 4. **OFF Hour Sweeps:** The system shall also support after hours OFF sweeps of selected relay or groups of relays at user defined one, two, or three-hour intervals.
- L. **Relay Output OFF Options:** Each relay shall have the option to control the relay OFF in a certain way other than the default OFF.
1. **Single Blink Alert:** Each relay output within the programmable lighting controller shall be individually programmable to blink and postponed prior to being turned OFF. The alert time shall be programmable from 2 to 99 minutes. The blink alert function shall blink each relay twice prior to turning OFF with a timer OFF sweep to warn occupants of the upcoming OFF event. If an ON command is received during the blink alert time, the relay output shall be overridden and left ON for the override time. Override times shall be adjustable from 5 to 999 minutes in 1-minute increments.
 2. **Double Blink Alert:** Each relay output within the programmable lighting controller shall be individually programmable to blink and postponed prior to being turned OFF and then blinked 1 minute before turning OFF. The alert time shall be programmable from 2 to 99 minutes. The blink alert function shall blink each relay twice for each alert to warn occupants of the upcoming OFF event. If an ON command is received during the blink alert time, the relay output shall be overridden and left ON for the override time. Override times shall be adjustable from 5 to 999 minutes in 1-minute increments.
 3. **HID Delay:** Each relay output within the programmable lighting controller shall have the ability to be controlled like a Single Blink Alert as described above but without the blink alert to prevent damage to HID lamps.
 4. **Alarm ON:** Relays shall be capable of performing a momentary ON function. The ON function shall be programmable from 1 to 99 seconds.
 5. **Alarm OFF:** Relays shall be capable of performing a momentary OFF function. The OFF function shall be programmable from 1 to 99 seconds.
 6. **Alarm Pulsed ON:** Relays shall be capable of being cycled ON and OFF at 1-second intervals and returning to the OFF state. It shall be programmable from 1 to 90 seconds.

7. **Alarm Pulsed OFF:** Relays shall be capable of being cycled OFF and ON at 1-second intervals and returning to the ON state. It shall be programmable from 1 to 90 seconds.
 8. **Automatic Control Switch-OFF:** Relays shall be capable of being cycled OFF for 5 seconds and then returned to the ON state for controlling Sentry or AS110 switches.
 9. **Automatic Control Switch-Blink:** Relays shall be capable of being cycled OFF for 1.5 seconds and then returned to the ON state for controlling Delay-OFF mode on AS110 switches.
- M. Presets:** The lighting controller shall support up to 256 user-defined presets of ON/OFF relay patterns. The presets shall be invoked by a switch or timer actuation.
- N. Descriptive Names:** The system shall support the optional assignment of descriptive names (up to 10 characters) to the lighting controller, relay outputs, relay groups, inputs, timers, and presets. These names shall be able to switch from custom names to default names.
- O. Password Protection:** Each Programmable controller shall have user definable 6 digit alphanumeric passwords with 2 levels of access. It shall have control and edit for level 1 and control only access for level 2.
- P. Networking:**
1. **Network Capacities:** In addition to the data line devices mentioned in Section D, LightLEEDer Controllers shall be linked together on the data line to form a Local Area Network (LAN) of up to 254 controller nodes.
 2. **Network Features:** The basic network manager shall allow connection of up to 254 controllers and 254 data line devices (on top of the 64 devices per panel) and provide USB communications. The advanced network manager shall have a high-speed LightSync scanner, 4 gateway device ports, power for LightSync devices, and TCP/IP along with the items in the basic network manager.
 3. **Network Universe:** The network of panels shall be capable to connect to other networks over a network (LAN) or over the internet (WAN) to interconnect multiple systems.
 4. **Network Gateway:** The following special purpose gateways shall be available and provides network wide control from a single point for its specialized function:
 - a) **DTMF Telephone Control:** The telephone gateway shall support the control of relays, presets and groups on the network via voice prompted commands and DTMF signals from a touch-tone telephone.

- b) **DMX Control:** The DMX gateway shall support the control of relays on the network from a single point connection using standard USITT DMX512 protocol used by theatrical lighting systems.
 - c) **Modbus Control:** The Modbus gateway shall support communications from the BAS system using Modicon Modbus protocol from a single point connection. All network input status, relay status, and control shall be supported.
 - d) **N2 Control:** The N2 gateway shall support communications from the BAS system using a Metasys-N2 protocol from a single point connection. Network wide group status and control shall be supported.
 - e) **BACnet Control:** The BACnet gateway shall support communications from the BAS system using BACnet MSTP or BACnet IP protocol from a single point connection. It shall allow up to 500 single relays, 100 multiple relays, 48 groups, and 48 presets.
 - f) **LonWorks Control:** The LonWorks gateway shall support communications from the BAS systems using LonWorks protocol from a single point connection. It shall allow up to 200 single relays, 100 multiple relays, 48 groups, and 48 presets.
5. **BAS System / Lighting Control System:** Programmable lighting controllers integrated/interfaced to other building control and alarm systems must remain completely functional and continue to process all programmed commands, including time schedules and local switching.

- Q. Runtime Logging and Trending:** Each lighting control panel shall be capable of logging Runtime and Trending data for each relay. This data shall be able to be harvested and exported from the entire system.
- 1. Runtime Logging:** The controller shall be able to internally log the runtime of each relay for up to 30 days. This data shall be able to be harvested with a personal computer at 1-minute intervals.
 - 2. Logging and Trending Software:** Runtime Logging and Trending software shall be available for harvesting data from the lighting control panels. It shall have a dedicated personal computer connected to the system through a LAN or USB cable to the panel or network controller.
 - a) Load Configuration:** Each relay in the system shall be able to have a wattage load assigned to it to represent the actual load on the relay. Loads shall be able to be named, or names shall be exported directly from the system programming software.
 - b) Combined Loads:** Up to 254 combined relay loads shall be allowed, for total wattage recording of areas in the facility. The combined loads shall allow relays from any panel in the network. Combined loads shall be able to be named for identification in reports and graphs.
 - c) Daily or Monthly Usage Report:** The software shall be capable of generating spreadsheet reports in a daily or monthly format for each relay or combined relays in the system.
 - d) Export Data:** The compiled reports shall be able to be exported to a .csv (comma separated value) file. These files when exported shall be coded for the year, month, and date.
 - e) Daily or Monthly Usage Graphs:** The software shall be capable of generating usage graphs in a daily or monthly format for each relay or combined relays in the system.
 - f) Printing:** Daily or monthly usage graphs shall have the capability to be directly printed from the software.
 - g) Live Usage Graphs:** The software shall have 1 to 9 live usage meter dials to display the present wattage of combined loads.

LL-EVO DISTRIBUTED LIGHTING CONTROLLER:

- A. LL-EVO Distributed Lighting Controller:** Each controller shall be designed to be remotely installed and provide control of 1-4 remote load control relays. This controller shall have the same features as the Programmable Lighting Control Panels excluding add-ons and naming.
- 1. Enclosure:** Each controller shall be provided with a NEMA 1 galvanized steel enclosure with a removable screw cover. It shall also be provided with a 1/2" nipple for mounting directly onto a junction box and pre-drilled mounting holes.
 - 2. Plenum Rated:** Each controller shall be suitable for plenum mounting. Controllers without this rating shall be unacceptable.
 - 3. Controller Power Supply:** Each lighting controller shall be provided with a dual-rated, UL listed Class 2 transformer capable of either 120/277 VAC or 120/347 VAC primary (50 to 60 Hz). It shall contain an internal self-resetting fuse.
 - 4. High Voltage Connections:** Each controller shall be provided with 6" color coded wire leads for terminating the high voltage connections. All connections shall be made to clearly and permanently labeled termination points.
 - 5. Low Voltage Connections:** Controllers shall also be provided with RJ45 connectors for the data line connections and remote relays. It shall also be provided push-to-connect connectors for occupancy sensors, dimming, and photocells. All connections shall be made to clearly and permanently labeled termination points.
 - 6. Occupancy Sensor Inputs:** It shall have 4 independent inputs, and each input shall be able to interface multiple occupancy sensors or hardwired switches. Each input shall control any or all the relays in the lighting controllers or the dimmer outputs. Each controller shall provide 24VDC total power for the occupancy sensors with the following current capabilities:
 - 200mA w/4 LightSync devices connected to controller
 - 160mA w/5 LightSync devices connected to controller
 - 120mA w/6 LightSync devices connected to controller
 - 90mA w/7 LightSync devices connected to controller
 - 60mA w/8 LightSync devices connected to controller

- 7. Photocell Inputs:** It shall provide an integrated interface for up to 2 ILC photocell heads. The photo controller shall be provided with 256 light to dark levels (0-1800fc). It shall allow selection of 8 individual set points for OFF and ON and includes a selectable range of dead-band. It shall be programmable for 2 or 30 seconds delay. Each set point shall control any or all of the relays in the lighting controllers or the dimmer outputs.
- 8. Local Data Line Port:** It shall provide an RJ45 data line port for up to 61 LightSync data line devices. It shall provide power for LightSync devices as described in item “F”, or additional power added with an optional Power Supply Repeater.
- 9. Dimming:** Room controllers shall be provided with 4 independent 0-10V dimming control outputs that shall sink a maximum of 100mA per output. Each output shall be galvanically isolated up to 1500V to protect the electronics. Each output will revert to 100% upon a power loss.
- 10. Real-Time Clock:** Each controller shall be provided with a Real-Time Clock used to perform all time-controlled functions. It shall use a high voltage line-sync circuit for timing and a crystal for backup. Clock accuracy shall be held +/- 2 minutes per year and displayed to the second with the line-sync setting. Real-Time Clock functions shall include time of day, day of week, date and automatic daylight-saving time and leap year adjustments. Time clock shall be protected against loss of time during a power outage for a period of up to 45 days without power of any type. Daylight Saving Time shall be adjustable with an enable/disable feature. Systems relying on a single clock device shall not be acceptable.
- 11. Pre-Configured Programs:** Each controller shall have up to 16 pre-configured lighting application programs. Each lighting application program shall be selectable with a switch on the controller.

B. Remote Relays: Each distributed lighting controller shall be provided with 1-4 single pole R20 or R20D relays.

1. **Remote Relay Enclosure:** Each remote relay enclosure shall be made of ABS/PC plastic that is UL recognized.
2. **Mounting:** Each relay shall have a ½” electrical nipple for attaching to an electrical box. It shall also be provided with a ½” conduit nut for fastening.
3. **Line Voltage Connections:** Each relay shall be provided with 600V 6” wire leads for connection to line and load. Leads shall exit through the nipple of the relay.
4. **Low Voltage Connections:** It shall be provided with an RJ45 connector for interfacing and controlling the relay.
5. **Latching Relay:** The relay shall be a latching relay and shall not change state upon a power loss.
6. **Ratings:** The remote relays shall be rated for a minimum of 16 amps, and up to 347VAC. It shall be rated for resistive, general, ballast, and electronic ballast loads. It shall be able to control 1/2HP motor loads up to 120VAC.
7. **0-10V Dimming:** An optional 0-10V dimming relay shall be provided, designated as R20D. Wire leads shall be provided and shall exit through the nipple of the relay. Leads shall be a minimum of 6” in length. It shall be acceptable to wire the 0-10V connection with the Class 1 wiring. Each relay shall be able to sink the 0-10V dimming up to 100mA.
8. **Certifications:** Each relay shall be UL/CUL listed to UL916 specifications. They shall be FCC Part 15. 109, Class B approved for radiated and conducted emissions.
9. **Plenum Rating:** The relay shall be plenum rated and clearly marked.
10. **Made in the USA:** Each relay shall be Made in the USA. Relays manufactured other than the USA shall be unacceptable.

2.2 ROOM CONTROLLERS:

- A. 2-Load Room Controller:** Each controller shall be designed to be remotely installed and provide 2 load control relays, 4 independent Occupancy Sensor/Hardwire inputs, 2 independent 0-10V dimming outputs, 2 photocell head inputs, and a local port for 2 data line push-button switches. The room controllers shall be able to be stand-alone or networked from an Expansion Processor or lighting control panel.
1. **Enclosure:** Each room controller shall be provided with a NEMA 1 enclosure with a removable screw cover. It shall also be provided with a 3/4" nipple for mounting directly onto a junction box.
 2. **Control Voltage:** The room controller shall be available with 120/277VAC, or 120/347VAC control voltages.
 3. **Relays:** Each controller shall be provided with 2 single pole Reliant40 relays derated to 30 Amp tungsten or ballast loads at up to 347VAC.
 4. **Connections:** Each controller shall be provided with 6" color coded wire leads for terminating the high voltage connections. It shall also be provided with RJ45 connectors for the data line connections and push-to connect connectors for occupancy sensors, dimming, and photocells.
 5. **Occupancy Sensor Inputs:** Each room controller shall provide 4 hardwire inputs that can directly interface occupancy sensors or hardwired switches. Each room controller shall provide up to 200mA @ 24VDC total power for the occupancy sensors.
 6. **Photocell Inputs:** It shall provide an interface for up to 2 photocell heads.
 7. **Local Data Line Port:** Shall provide an RJ45 data line port for up to (2) 6 push-button switches.
 8. **Dimming:** Room controllers shall be provided with 2 independent 0-10V dimming ballast control outputs that shall sink a maximum of 100mA per output.

- B. 4-Load Room Controller:** Each controller shall be designed to be remotely installed and provide up to 4 load control relays, 4 independent Occupancy Sensor/Hardwire inputs, 4 independent 0-10V dimming outputs, 2 photocell head inputs, and a local port for 2 data line push-button switches. The room controllers shall be able to be stand-alone or networked from an Expansion Processor or lighting control panel.
1. **Enclosure:** Each room controller shall be provided with a NEMA 1 enclosure with a removable screw cover.
 2. **Control Voltage:** The room controller shall be available with 120/277VAC, or 120/347VAC control voltages.
 3. **Relays:** Each controller shall be provided with up to 4 single pole Reliant40 relays rated for 40 Amp tungsten or ballast loads at up to 347VAC.
 4. **Connections:** Each relay shall be provided with terminals for 2 line and 2 load wires. It shall also be provided with RJ45 connectors for the data line connections and push-to connect connectors for occupancy sensors, dimming, and photocells.
 5. **Occupancy Sensor Inputs:** Each room controller shall provide 4 hardwire inputs that can directly interface occupancy sensors or hardwired switches. Each room controller shall provide up to 200mA @ 24VDC total power for the occupancy sensors.
 6. **Photocell Inputs:** It shall provide an interface for up to 2 photocell heads.
 7. **Local Data Line Port:** Shall provide an RJ45 data line port for up to (2) 6 push-button switches.
 8. **Dimming:** Room controllers shall be provided with 4 independent 0-10V dimming ballast control outputs that shall sink a maximum of 100mA per output.
- C. 4-Load Expansion Panel:** Each panel shall be designed to be remotely installed and provide up to 4 load control relays. It shall also provide means to mount up to 2 interface modules and 1 photocell controller. Interface modules shall include; 4 input module, 4 occupancy sensor input module, 8 occupancy sensor input module, 4 photocell sensor controller, and dimming module.
1. **Enclosure:** Each remote expansion panel shall be provided with a NEMA 1 enclosure with a removable screw cover.
 2. **Control Voltage:** The remote expansion panel shall be available with 120/277VAC, or 120/347VAC control voltages.

3. **Relays:** Each controller shall be provided with up to 4 single pole Reliant40 relays rated for 40 Amp tungsten or ballast loads at up to 347VAC.
4. **Connections:** Each relay shall be provided with terminals for 2 line and 2 load wires. It shall also be provided with RJ45 connectors for the data line connections.

D. Expansion Processor: Each processor shall provide the Room Controllers the full ability and all of the functions of the Programmable Lighting Control Panels. With the addition of a Network Controller, the Room Controllers shall communicate with other lighting control panels and other Room Controller subnets.

E. Room Controller Capabilities:

1. **Subnet Capability:** Each Room Controller subnet shall be able to support up to 16 Room Controllers of any type.
2. **Network Wide Capability:** With the addition of a Network Controller, Room Controller subnets shall reside with the Programmable Lighting Control Panels 254-panel capabilities. It shall support up to 254 Room Controller subnets for a total of 4064 panels or 16,256 control relays.
3. **Room Controllers W/Relay Panels:** Room Controllers shall be allowed to be connected to a Programmable Control Panel with Relay Driver Modules and relays. For every Relay Driver Module connected to the controller, the subnet capability for the Room Controllers shall decrease by 2 panels.

F. Room Controller Programming:

1. **Stand-alone:** 2 and 4 load Room Controllers shall be programmable as a standalone lighting controller. Room Controllers shall be capable of being programmed, monitored, or backed-up using the Windows-based graphical software.
2. **Networked:** Room Controllers and Programmable Control Panels shall be capable of being programmed, monitored, backed-up, or controlled through any of the below methods. All programming changes shall take effect immediately as they are programmed and shall not suspend or disable switches or other system functions. The same functions shall be available for any of the connection types.

- a) **Local Keypad and Display:** The system user shall be able to program, monitor and control any of the controller features and functions through the use of simple menu-driven self-prompting user interface consisting of a 4-line 20-character backlit LCD display and 8 selection keys that change function based on the current operating mode.
- b) **USB Serial Direct Connect:** The system user shall be able to program, monitor or control any of the controller features and functions utilizing LightLEEDer Pro Windows-based graphical user interface software using a USB port from a PC.
- c) **Modem Connect:** The system user shall be able to remotely program, monitor or control any of the controller features and functions utilizing LightLEEDer Pro Windows-based graphical user interface software using a PC/modem on an analog phone line.
- d) **TCP/IP Connect:** The system user shall be able to remotely program, monitor or control any of the controller features and functions utilizing LightLEEDer Pro Windows-based graphical user interface software using a PC with TCP/IP on a LAN or WAN.

2.3 LIGHTING CONTROL RELAYS:

A. Reliant40-1 Single Pole Relay

1. **Listing:** Lighting control relays shall be individually UL and CUL listed and shall bear labels indicating compliance.
2. **Labeling:** Lighting control relays shall bear labels for relay current and SCCR ratings.
3. **Endurance:** Lighting control relays shall be designed and tested to have a minimum cycle life of 200,000 ON/OFF cycles @ FULL LOAD and 2,000,000 ON/OFF cycles at no load.
4. **SCCR:** Lighting relays shall have an SCCR rating of 18,000 amps up to 347 VAC.
5. **Loads:** Lighting control relays shall be designed for control of 120, 277 or 347 VAC lighting control circuits at a full 40 AMPS for Tungsten or Ballast loads, 16 AMPS for Electronic Ballasts (UL limit), and motor loads of 1.5 Hp @ 120 VAC.

6. **Latching:** Lighting control relays shall be designed with a latching mechanism that shall hold the relay in its last activated state indefinitely, with no change of state during an interruption of power. Solid state or electrically held relays are not acceptable.
7. **Auxiliary Contacts:** Each Lighting control relay shall contain an auxiliary set of contacts rated at 1 AMP 30 VAC/VDC electrically isolated but mechanically linked to the main contacts for the purpose of true status monitoring and pilot light activation.
8. **Mounting:** Relays shall be capable of panel mounting.
9. **Lock-Out:** Relays shall be equipped with an Enable/Disable switch to lock out On/Off control from the controller.
10. **Actuator:** Relays shall be equipped with a manual actuator switch for turning the relay ON or OFF along with status indication.

B. Reliant40-2 and 3 Pole Relay:

1. **Multipole:** Electrical contractor shall provide quantities of 40 AMP 2 or 3 pole relays as indicated on the drawings and schedules as specified herein.
2. **Labeling:** 40 AMP 2 or 3 pole relays shall be individually UL and CUL listed and shall bear labels indicating compliance.
3. **Voltages:** 40 AMP 2 or 3 pole contactors shall be designed for the control of 208, 240 and 480 VAC lighting loads at a full 40 Amps.
4. **Mechanical Link:** Poles within the relay shall be electrically isolated but mechanically linked so as to open and close together without the possibility of one pole being closed while the other remains open. Systems that utilize two single-pole relays to accomplish this function are not acceptable.

2.4 SWITCH STATIONS AND COVER PLATES

A. Hardwired Switches and Cover Plates: Electrical contractor shall provide and install switch plates and switches of the quantities and types shown on the drawings and specified herein.

1. NFP Momentary Switch

- a) **Switch:** It shall consist of a single-pole double-throw center OFF momentary switch rated at 6 Amps @ 125 VAC. They shall be available in black, white, gray, or red colors
- b) **Cover Plates:** Plates shall be available in stainless steel, brushed aluminum, or painted cold rolled steel. They shall be available with 1-3 switches per single gang plate and 4-8 in a 2-gang plate.
- c) **Status:** LED status indicators shall be optional for each switch provided.
- d) **Nomenclature:** Engraving shall be available on phenolic labels or directly on the plate.

2. Heavy Duty Switch

- a) **Switch:** It shall consist of a single-pole double-throw center OFF momentary heavy-duty toggle or Decora® paddle switch rated at 15-20 Amps @ 120/277 VAC. They shall be available in ivory or white colors.
- b) **Cover Plates:** Plates shall be available for Decora® switches in ivory, white, or stainless steel with or without visible screws and come in 1-4 gangs.
- c) **Nomenclature:** Engraving shall be available on phenolic labels or directly on the plate.

3. Key Switch

- a) **Key Switch:** Key switch shall consist of a single-pole double-throw momentary or maintained switch. They shall be available to allow the key to being removed in the ON position or the OFF position.
- b) **Cover plates:** Plates shall be available in stainless steel, brushed aluminum, or painted cold rolled steel. They shall be available with 1-2 switches per gang plate and up to 4 gangs.
- c) **Status:** LED status indicators shall be optional for each switch provided.

- d) **Nomenclature:** Engraving shall be available on phenolic labels or directly on the plate.

4. Touch Activated Switch

- a) **Switch:** Touch activated switch shall be a momentary output solid-state piezo type push button.
- b) **Cover plates:** Plates shall be available in stainless steel, brushed aluminum, or painted cold rolled steel. They shall be available with 1-3 switches per gang plate and up to 4 gangs.
- c) **Gasket:** Cover plate neoprene gaskets shall be available for weatherproof applications.
- d) **Status:** LED status indicators rings shall be optional for each switch provided.
- e) **Nomenclature:** Engraving shall be available on phenolic labels or directly on the plate.

B. Custom Switch Plates and Graphic Switch Stations: Electrical contractor shall provide and install custom switch plates and graphical switching stations of the quantities and types shown on the drawings and specified herein.

- a) **Switch Plates:** Switch plates shall consist of a control panel faceplate, switches, and other control devices as required, LED pilot lights and all mounting hardware.
- b) **Material:** Switch plates shall be manufactured from a single piece of stainless steel, aluminum, brass or bronze, finished and labeled as per the plans and specifications or as indicated on approved drawings.
- c) **Mounting:** Switch plates shall be designed to mount either to a standard electrical gang box supplied by the electrical contractor for either flush or surface mounting or to a custom back-box supplied by the manufacturer.
- d) **Nomenclature:** Switch plate graphics and labeling shall be accomplished through the use of one or a combination of multi-color anodized, engraving or phenolic labels; laser etched or painted graphics.

- e) **Graphics:** Each switch station shall contain a graphic representation of the controlled space with switches and other control devices graphically located on the station so as to indicate their associated areas of control.

PART 3 – EXECUTION

3.1 INSTALLATION

1. **Installation:** Where shown in the drawings, the contractor shall furnish and install programmable lighting controllers of the quantities, sizes, and types shown on the drawings or specified herein.
2. **Requirements:** All equipment shall be installed in accordance with manufacturer requirements and in compliance with all applicable local and national codes and requirements.

3.2 MANUFACTURES SERVICES

1. **Factory Programming:** All controllers shall be factory programmed upon request in accordance with the project specifications prior to shipment.
2. **Installation Assistance:** During the installation process, the manufacturer shall provide, at no cost, technical support via a toll-free telephone line to the installing contractor or owner's representative to answer questions and supply additional information when required.
3. **System Start-Up:** The system manufacturer shall provide a factory authorized field technician to the project site after installation has been completed and prior to the system being energized for the purpose of testing and adjustment of the system. Factory field technician shall test and verify all system functions and ensure proper operation of the system components in accordance with the specifications and on-site conditions. The installing contractor shall notify the system manufacturer in writing that the system is completely wired and ready to be energized and tested 4 weeks prior to scheduling a field technician for the start-up of the system. Should the field technician arrive on the job site and find the installation incomplete, the installing contractor shall pay the cost of any future visits by the field technician required to complete the system start-up.
4. **On-Site Programming:** During the start-up procedure, the factory field technician shall provide programming assistance and guidance to the building operating personnel in order to program the systems for initial operation.
5. **Instruction:** During the start-up procedure, the factory field technician shall provide training to the building operating personnel in the operation, programming, and maintenance of the lighting control system.
6. **As-Built Drawings:** After completion of the system installation and testing, the manufacturer shall provide 3 sets of "as-built" drawings.

7. **Operation and Maintenance Manuals:** After completion of the system installation and testing, the manufacturer shall provide 3 sets of Operations and Maintenance Manuals.
8. **Lifetime Toll-Free Telephone Support:** The system manufacturer shall provide a toll-free telephone number to the system user and shall allow access to free telephone support for the life of the system.