

SECTION 16147A

LIGHTING CONTROL SYSTEM - POW-R-COMMAND 1000)

PART 1 GENERAL

1.01 SCOPE

- A. The Contractor shall furnish and install the Lighting Control System as specified and as shown on the contract drawings.
- B. The Lighting Control System work shall be indicated on the drawings and by the requirements of this section. It is defined to include, but not limited to:
 - 1. Power switching equipment
 - 2. Lighting management equipment
 - 3. System management equipment
 - 4. System operator's equipment
 - 5. Factory service

1.02 RELATED SECTIONS

- A. Section 16470 – Panelboards
- B. Section 16475 – Circuit Breakers and Fusible Switches – Low Voltage
- C. Section 16911 – Power Management System
- D. [∃]Division 15 – Building Automation System/Energy Management System

1.03 REFERENCES

- A. NEMA Compliance: Comply with applicable portions of NEMA standards pertaining to types of electrical equipment and enclosures.
- B. UL Listing: Panelboards with Integral Intelligence are to be UL listed under UL 916 Energy Management Equipment, UL 67 Panelboard Interiors and UL 50 Panelboard Box.
- C. [∃]California Title 24: All control equipment shall be California Title 24 compliant.
- D. [∃]New York City Authority: All panelboards shall be certified for use in New York City by the New York City Authority.
- E. FCC Emissions: All control equipment shall be in compliance with FCC emissions standards in Part 15 Subpart J for Class A application.

1.04 SUBMITTALS – FOR REVIEW/APPROVAL

- A. The following information shall be submitted to the Engineer:
 - 1. Breaker layout drawing with dimensions indicated and nameplate designation
 - 2. Component list

[∃] Note to Spec. Writer – Optional

3. Conduit entry/exit locations
 4. Assembly ratings including:
 - a. Short-circuit rating
 - b. Voltage
 - c. Continuous current
 5. Cable terminal sizes
 6. Product data sheets. Submit manufacturer's data sheets on system submitted and components supplied, with complete descriptions of hardware and software components supplied
 7. Series rating information
 8. ³Interface to Electrical Monitoring and Control System
 9. ³Interface to Building Automation System/Energy Management System
- B. Wiring Diagrams – Submit typical wiring diagrams for all components including, but not limited to, smart panelboard, application specific controllers, override switches, daylighting components, dimming ballasts, telephone lines, network wiring, and the central operator's station.
- C. One line diagram – Submit a one line diagram of the system configuration submitted with notations explaining any differences from that illustrated in the riser diagram included in the specifications.

1.05 SUBMITTALS – FOR CONSTRUCTION

- A. The following information shall be submitted for record purposes:
1. Final as-built drawings and information for items listed in Paragraph 1.04, and shall incorporate all changes made during the manufacturing process
 2. Installation information
 3. Seismic certification and equipment anchorage details as specified

1.06 QUALIFICATIONS

- A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- D. ³Provide Seismic tested equipment as follows:
1. The equipment and major components shall be suitable for and certified to meet all applicable seismic requirements of the International Building Code (IBC) for zone 4 application. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment. The test response spectrum shall be based upon a 5% minimum damping

³ Note to Spec. Writer – Optional

factor, IBC: a peak of 2.45g's (3.2-11 Hz), and a ZPA of 0.98g's applied at the base of the equipment. The tests shall fully envelop this response spectrum for all equipment natural frequencies up to at least 35 Hz.

-- *OR --

1. The equipment and major components shall be suitable for and certified to meet all applicable seismic requirements of the California Building Code (CBC) through zone 4 application. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment. The test response spectrum shall be based upon a 5% minimum damping factor, CBC: a peak of 2.15g's, and a ZPA of 0.86g's applied at the base of the equipment. The tests shall fully envelop this response spectrum for all equipment natural frequencies up to at least 35 Hz.

-- *OR --

1. The manufacturer may certify the equipment based on a detailed computer analysis of the entire assembly structure and its components. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment
2. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.
 - a. The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed civil engineer in the state. Mounting recommendations shall be provided by the manufacturer based upon approved shake table tests used to verify the seismic design of the equipment.
 - b. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.
 - c. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.
- E. The manufacturer of the lighting control system shall be regularly engaged in manufacture of electrical distribution equipment, lighting control and/or energy management equipment of types and capacities required and shall be the manufacturer of the remote controllable circuit breakers contained in the system.

1.07 REGULATORY REQUIREMENTS

- A. The lighting control system shall be UL labeled. Panelboards with Integral Intelligence shall be UL listed under UL 916 Energy Management Equipment, UL 67 Panelboard Interiors and UL 50 Panelboard Box.
- B. All control equipment shall be in compliance with FCC emissions' standards in Part 15 Subpart J for Class A application.

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1.08 DELIVERY, STORAGE AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.09 OPERATION AND MAINTENANCE MANUALS

- A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton / Cutler-Hammer products
- B. _____
- C. _____

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the engineer ten (10) days prior to bid date.

2.02 GENERAL

- A. The Lighting Control System shall meet or exceed the following capabilities:
 1. The Lighting Control System shall be networkable and consist of smart panelboards for zone power switching. The system shall be capable of utilizing smart application specific controllers to provide application specific control of daylight harvesting of fluorescent lighting, manual switch override of automated system functions, telephone override of automated system functions, remote access, and historical data logging. The system shall be capable of remote monitoring and programming through a remotely located personal computer with modem capability. On-site programming and monitoring shall be through a networked central operator's station or through a laptop PC. In addition, each panelboard must be able to be locally accessed by a mobile device. The panel must be able to carry out all switching functions without the use of the PC or mobile device. The programming software, for both PC and mobile device, shall be Microsoft Windows-based and be capable of programming and monitoring all system functions. Factory service and associated wiring to allow control of the facility shall be supplied
- B. The intelligent panelboards shall be mounted in electrical closets as indicated on the drawings. The numbered breakers in the panels shall be wired to control the power to each circuit as indicated on the panel wiring schedules included in the drawings. Override switches and other low voltage devices shall be mounted and wired to individual controllers

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as shown on the drawings. All wiring shall be identified with the number of the breaker, switch or low voltage device.

- C. The application-specific controllers shall be mounted in an expansion cabinet or mounted integral to the panelboard as indicated on the drawings. The application-specific controllers shall be wired to their specific application as indicated on the wiring schedules and drawings. All control wiring shall be identified with the number of the ballast, telephone line extension, low voltage switch, sensor, tenant meter, or HVAC equipment as required.
- D. The Central Operator's Station shall be located and connected to the network as indicated on the drawings. The station shall be located in an area relatively free of moisture, dust and harsh environments.
- E. Electronic Dimming Ballasts, Photosensors, Override Switches, Occupancy Sensors, Tenant Meters and Wall Box Dimmers shall be provided by the contractor and mounted in the spaces as indicated on the drawings. Low voltage wiring shall be Class 2 or Class 2P (plenum rated) as required by the National Electrical Code and local standards. Each low voltage control wire shall be labeled with the circuit number at each switch, ballast, tenant meter or sensor. Use stranded #18 AWG or larger wire as indicated on the drawings. Remote controlled circuits shall be recorded on the directory card in each expansion cabinet.
- F. The network of intelligent panelboards and application specific controllers shall support at least 120 controllers. For larger systems, up to 15 networks of 120 controllers can be connected to form one logical network.

2.03 POWER SWITCHING EQUIPMENT REQUIREMENTS

- A. The power switching equipment shall be intelligent panelboards. The intelligent panelboards shall contain low voltage controlled circuit breaker switching and thermal magnetic overcurrent protection in a standard panelboard enclosure. The intelligent panelboards must be integrated and modular, external time clocks, and contactor circuits will not be acceptable.
- B. Intelligent Panelboard General Requirements:
 - 1. The intelligent panelboard shall contain an integral programmable plug and play panelboard control module that provides ON/OFF control for low voltage switchable circuit breakers and network communications capability
 - 2. Panelboards shall be individually capable of time-of-day scheduling, ON/OFF zone control and panelboard-to-panelboard global communication with up to 120 intelligent panelboards per system globally communicating over a main shielded twisted pair network to a central operator's station
 - 3. The panelboard shall be integrated, use modular construction, and be capable of accepting an intelligent programmable panelboard control module. The panelboard shall be pre-wired and assembled at the factory and consist of the following modular construction:
 - a. Enclosure to be standard 20-inch wide x 5-3/4 inch deep NEMA Type 1.
 - b. Trim to be standard 20-inch wide NEMA Type 1.
 - c. Circuit breakers shall be of such type that may be remotely controlled ON or OFF with Class 2 low voltage.

- d. Interior to be sized to Distribution System Characteristics, Voltage and Current requirements.
 - e. Internal Remote Controllable Circuit Breaker Electronic Bus.
 - f. Internal Intelligent Panelboard Control Module.
 - g. Internal Class 2, 120/277 Vac Power Supply with primary fuse and secondary thermal magnetic On/Off protection.
 - h. Class 2 barrier.
 - i. Intelligent panelboard control module to be listed as UL 916 Energy Management Equipment.
4. Each intelligent panelboard shall be capable of controlling up to 3 additional slave panelboards. Slave panelboards are powered and controlled from the intelligent panelboard. The intelligent panelboard controller must be capable of controlling up to 168 remote controlled breakers. Slave panelboards must be located within 200 feet of the intelligent panel board.

C. Intelligent Panelboard Construction Requirements:

1. The panelboard shall be rated for *[480Y/277] [120/208Y] Vac, or as shown on the drawings. Continuous main current ratings shall be as indicated on the drawings, not to exceed 400 amperes maximum for main breaker or main lugs. Minimum short circuit current rating shall be *[14,000 at 480/277 Vac] [10,000 at 120/208 Vac]. Panelboard shall be fully rated or series rated to meet the panelboard short circuit current rating shown on the drawings
2. Panelboard bus current rating shall be determined by heat-rise tests conducted in accordance with UL 67. Provide one (1) continuous vertical bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors suitable for bolt-on branch circuit breakers. The bussing shall be fully rated. Bussing shall be *[aluminum] [copper]. Panelboards shall be suitable for use as Service Equipment where shown on the drawings
3. Neutral shall be 200% rated solid copper for non-linear load applications and marked for non-linear load applications
4. Main and sub-feed circuit breakers shall be vertically mounted. Nametags shall be provided and secured to the deadfront with screws
5. Interiors shall be capable of housing an intelligent panelboard control module and sized to allow easy access and replacement of the intelligent panelboard control module
6. Interiors shall provide a Class 2 separation for the panelboard control module with an internal Class 2, 120/277 Vac Power Supply with secondary thermal magnetic ON/OFF protection to provide power to the panelboard control module
7. Interiors shall come complete and factory assembled with rigid chassis assembly that assures accurate alignment of interior and intelligent panelboard control module with panel front and prevent flexing and possibility of loosening or damage to parts during and after installation
8. Interior shall provide deadfront cover for access to intelligent panelboard control module
9. Control module shall provide operating information to include:

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- a. Local programming/diagnostic port
 - b. Intelligent panelboard control module ON/OFF switch
10. Main Circuit Breaker:
- a. Main circuit breakers shall have an overcenter, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Thermal elements shall be true rms sensing and be factory calibrated to operate in 40 degrees C ambient.
 - b. Two- and three-pole circuit breakers shall have common tripping of all poles. Circuit breaker frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the breaker. Breaker handle and faceplate shall indicate rated ampacity.
 - c. Lugs shall be UL listed to accept solid or stranded (copper and aluminum conductors only). Lugs shall be suitable for (75 degrees C rated wire), (90 degrees C rated wire, sized according to the 75 degrees C temperature rating per NEC Table 310-16). Lug body shall be bolted in place, snap-in designs are not acceptable.
11. Branch Circuit Breakers:
- a. Branch circuit breakers shall have bolt-on type bus connectors.
 - b. Circuit breakers shall have an overcenter toggle mechanism, which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole circuit breakers shall have common tripping of all poles.
 - c. There shall be two forms of visible trip indication. The circuit breaker handle shall reside in a tripped position between ON and OFF. In addition, there shall be a trip indicator appearing in the window of the circuit breaker housing.
 - d. Circuit breakers marked "Remotely Controlled" on drawings shall be of the remote controllable latching type. Circuit breaker contacts shall respond to a remote low voltage Class 2 signal for Open or Closed contact positioning. Circuit breaker power contacts shall remain Open when the breaker handle is in the OFF or tripped position, regardless of the remote low voltage Class 2 signal. Remote control shall only be possible when the breaker handle is in the ON position. Circuit breakers may be manually controlled by operating the breaker handle in the event of a panelboard control module hardware failure. Control power to the remotely controlled circuit breakers shall come from the intelligent panelboard control module.
12. Enclosures:
- a. Type 1 Boxes shall be standard size 20-inch wide x 5-3/4-inch deep galvanized steel constructed in accordance with UL 50 requirements. Boxes shall have removable box ends without knockouts on both ends.
 - b. Fronts shall meet strength and rigidity requirements per UL 50 standards with ANSI-61 Gray finish over cleaned steel. Fronts shall be one-piece with hinged flush-type lock/latch handle assembly on door and mounting screws. Mounting shall be flush or surface as indicated on the drawings.
 - c. Gutter space shall meet or exceed UL and NEC requirements.
- D. Intelligent Panelboard Control Requirements:
- 1. The panelboard shall be distributed intelligent and operate as a stand-alone device that can control its own process

2. The panelboard shall be capable of globally communicating with other panelboards and the central operator's station over a main shielded twisted pair data network. The only need the panelboard shall have for the main shielded twisted pair data network is to send and receive information to other panelboards and the central operator's station when necessary
 3. A central operator's station shall not be required for the panelboard to send and receive messages from other panelboards on the network
 4. A panelboard resident port shall be provided for local laptop programming and diagnostic maintenance
 5. The panelboard shall be capable of coordinating all Logic, Control, Runtime Data, Status Information and Communications functions.
 6. Networking of up to 120 intelligent panelboards shall be possible in a single network. Up to 15 networks can be interconnected into one logical system
- E. Intelligent Panelboard Performance Requirements:
1. Hardware Requirements:
 - a. The panelboard controller shall be powered from a Class 2 ac power source. Power source shall be factory adjustable to operate on either 120 VAC or 277 VAC. Power source must be directly connected to bus.
 - b. Time schedules, time clock, day/date and panelboard configuration parameters shall be protected from memory loss if there is a power failure. The memory loss protection will be rated for a minimum of 10 years.
 - c. The panelboard controller shall have non-volatile memory. Subsequent to any loss of control power, the panelboard controller shall automatically reset and return to normally scheduled load position without any operator action required.
 - d. Serial Communications Port: RS-485 communications port shall be provided for local programming or maintenance.
 - e. The main network port shall permit up to 120 intelligent panelboards to be connected by a shielded twisted pair. The main network shall be a high speed, high reliability network designed to operate in the noisy environment of commercial and industrial buildings, while providing immunity to most power system interference.
 - f. The ability to accumulate load duration "on" time for all actuated loads shall be provided through the data control software.
 - g. Time of day, day/date, automatic leap year and daylight savings' time adjustments shall be provided.
 - h. The stand-alone feature shall permit the panelboard to operate without a central computer. All time-of-day functions such as load schedules, ON/OFF times, real-time clock, day/date, month, etc. shall be included. The only need the panelboard shall have for the main twisted pair network is to send and receive global information to and from other panelboards in the system. Global commands shall not be required to pass through the central computer, all global commands shall be passed between panelboards.
 - i. All controllers that contain an internal time function must be able to synchronize off of the network's main controller.
 - j. Each panelboard shall provide the ability to globally communicate over a main network with other panelboards using a shielded twisted pair dataline. The main network shall provide a highly reliable communication bus for transferring data.

- k. The networks shall be self-powered from the panelboard, no external power supply shall be required.
 - l. The panelboard shall remove itself from the main network should it fail. Network "Lock-Ups" due to failed panelboard shall not be acceptable.
 - m. The main network shall consist of one (1) twisted pair with shield meeting Class 2P, Belden 9207. Network characteristics shall be as follows: speed shall be 9600 Baud, maximum length shall be 4,000 feet (without repeaters), maximum number of smart panelboards shall be 120.
 - n. Each intelligent panelboard controller shall be capable of providing power and control for up to 3 slave panelboards. Slave panelboards must be located with 200 feet of the intelligent panel board controller. (Intelligent panel board controller shall be capable of controlling up to 168 remote controllable breakers.)
 - o. Each panelboard controller must at a minimum provide diagnostic LEDs for power, normal operation / fault, and network communication activity.
 - p. Each panelboard controller shall have at least 4 local switches for maintenance functions such as bypass all loads ON / OFF.
 - q. Each panelboard shall have general purpose low voltage I/O for local connection of override switches, occupancy sensors, ballasts, photo sensors, and pilot control relays. As a minimum each panel board shall support:
 - 1. Eight dry contact digital inputs for use with override switches, occupancy sensors, photocells, meter pulse contacts, or connection to other control systems.
 - 2. Eight universal inputs (analog or digital) for uses with override switches, occupancy sensors, photo sensors, light level override adjustment switches, temperatures, or connection to other control systems.
 - 3. Eight digital outputs for use with status LEDs, pilot relays for auxiliary controls, or connection to other control systems
 - 4. Four analog outputs for use with ballast control, auxiliary controls (4-20ma, 0-10v), or connection to other control systems
 - r. Each panelboard shall support an optional programming LCD panel. At a minimum the programming panel shall have an 8 line LCD to display parameters and status. Using buttons on the panel, a user may look at status, control local loads and modify load groups and schedules. User access shall be restricted based upon passwords. The programming panel shall also be capable of storing and loading panel control parameters from flash memory.
2. Hardware Resident Control Software Requirements:
- a. Each panelboard shall provide the control software as an integral part of the panelboard. The hardware resident software shall provide the ability to construct user-defined lighting control scenarios. It shall be possible to program the panelboard directly through its RS-485 port or over the main shielded twisted pair network via the central operator's station.
 - b. The panelboard management functions shall store and manage user-defined internal panelboard information such as the number of loads connected, real position of the load and whether a load is enabled. User variable timers shall be assigned to loads. These timers shall function as a timed switch and an OFF warning timer. Each load shall be able to be programmed to be enabled, disabled and alarm on an unrequested change of load position. The number of times a load has been cycled or

the duration of time the load has been in the ON position shall be individually stored per load. The following management functions shall be integral to the panelboard:

1. Manual Load Override Control shall be possible through the central operator's station keyboard or the laptop computer. Provide the ability for the operator to toggle individual loads ON and OFF or issue ALL ON and ALL OFF commands to individual panelboards from the keyboard
2. Each panel shall be programmable with up to 50 schedules. Each load shall have a 7-day weekly schedule. The panelboard shall monitor its programmed time schedules and determine when to turn the loads on and off at the programmed times and days. In addition to time of day schedules, each panel shall be capable of Astronomical scheduling from computed sunrise and sunset times.
3. Provide each load with the ability to preschedule up to 30 holidays
4. The Input-to-Output Matrix feature shall allow any load connected to any panelboard to be controlled by any switch, or any group of switches in the system
5. The panelboard shall maintain an alarm log. This log shall record where the alarm occurred, alarm reason, date and time of the alarm and log when the alarm was cleared and acknowledged. This log shall be maintained in non-volatile memory. The alarm log shall store up to 300 alarms
6. OFF Warning shall provide a method of warning tenants before a scheduled OFF time or time-out of a Telephone Override by blinking the lights. The time between the blink and the scheduled OFF time shall be adjusted by changing the warning lead-time. Once a blink has occurred, the tenant shall be able to cancel the upcoming "OFF" by toggling their local override switch or by overriding through the telephone. Once done, the lights shall stay on until the next scheduled OFF time or telephone time-out. The warning lead-time shall be user adjustable from 5 to 30 minutes
7. Provide the ability to check hardware status of the panelboard and individual loads by the operator either through the central operator's station, laptop computer, mobile PC or local LCD programming module. Malfunctions shall be highlighted allowing for quick and easy troubleshooting and servicing. Audible and visual alarms shall be generated when hardware malfunctions occur

2.04 LIGHTING CONTROL EQUIPMENT REQUIREMENTS

- A. The Lighting Control Equipment shall consist of individual lighting controllers for control of Switch Overrides, Voice Prompted Telephone Override, and Remote Access shall be plugged into an expansion cabinet. Expansion cabinets shall be of modular construction allowing plug and play installation of up to 3 application-specific controllers. The controllers shall serve as a function expander to either an intelligent panelboard to expand their functional control capability. Communication between an intelligent panelboard and its associated lighting controllers shall be over a shielded twisted pair network. Up to 120 intelligent panel controllers and associated lighting controllers shall be supported on a network. It shall be possible to remotely locate a controller up to 4,000 ft. from the furthest smart panelboard in the system. If a further distance is required, supply a manufacturer-recommended signal repeater. The controller shall be capable of coordinating all Logic, Control, Runtime Data, Status Information and Communications functions.
- B. The Universal System controllers shall share the following functions:
 1. The controller shall be powered from a Class 2 ac power source

2. There shall be LEDs for indicating the following conditions; normal controller operation, transmit and receive for the network, and power to the controller
3. Controller configuration shall be protected if there is a power loss. The memory backup will be rated for 10 years
4. When the controller input power drops below normal, the controller shall not lose its programmed information. Upon return of normal power load, position changes scheduled during the power failure period shall immediately be updated to the current scheduled position, or the load returned to the scheduled load position prior to the power failure. No operator interaction shall be required to return the controller to normal
5. The network shall be self-powered from the controller, no external power supply shall be required
6. The controller shall be able to remove itself from the expansion network should it fail. Network "Lock-Ups" due to failed controllers shall not be acceptable
7. The stand-alone feature shall permit the controller to operate without a central computer. All the functions such as configuration settings, ON/OFF times, real-time clock, automatic leap year, daylight savings' time adjustments, day/date, month shall be included. The only need the controller shall have for the expansion network is to send and receive global information to and from the smart panelboard
8. The controller shall maintain an alarm log. This log shall record where the alarm occurred, alarm reason, date and time of the alarm, and log when the alarm was cleared and acknowledged. This log shall be maintained in non-volatile memory. The alarm log shall store up to 300 alarms
9. Provide the ability to check hardware status of the controller and individual connected loads by the operator either through the central operator's station or the laptop computer. Malfunctions shall be highlighted allowing for quick and easy troubleshooting and servicing. Audible and visual alarms shall be generated when hardware malfunctions occur
10. Each controller shall provide the Windows-based control software as an integral part of the controller. The control software shall be hardware resident and provide the ability to construct user-defined control scenarios. It shall be possible to program the controller over the main shielded twisted pair network via the central operator's station. Software shall be able to perform basic grouping, scheduling and assigning functions, and shall be expandable to hold customized screens, or enable secure access to the system through the Internet
11. Each panel is programmable with up to 50 schedules. Each output may have a 7-day weekly schedule. The controller shall monitor its stored times schedule and set the programmed output values at the programmed times. In addition to time of day scheduling, the panel shall be capable of scheduling from computed sunrise and sunset times (Astronomical).
12. Provide each output with the ability to preschedule up to 30 holidays
13. Each panel shall have eight (8) two-wire control inputs that are either analog or digital type. Each panel shall have four (4) two-wire control inputs that are digital only. Each panel shall have three (3) two-wire outputs that are analog type. Each panel shall have a dc voltage source suitable for operation of devices such as sensors and ballasts
14. Each panel shall be locally accessible through a touch-sensitive mobile device such as a Pocket PC. Mobile device shall be capable of performing, through a Windows-based

environment, basic maintenance and programming functions. Each panel must be capable of full operation when this device is not present. The device must also be capable of operating software other than the software required for system control

15. Each system shall be accompanied by proper training material, including but not limited to, software manuals, operating instructions for components, and a training video for system components

C. ³Switch Override Control

1. The Switch Override Control equipment shall be a controller that will provide the ability to monitor up to 48 two-wire contact closures from Wall Switches, Occupancy Sensors, and Building Automation System Dry Contacts. Inputs shall be Class 2 self power-reducing low voltage ac and be individually custom programmable to operate differently. It shall be possible to program any input to control any load or group of loads in the system. Inputs shall be capable of being individually time scheduled for different days of the week with no less than 30 holidays. Up to 120 switch override controllers shall be possible per system
2. Hardware Requirements
 - a. There shall be 48 two-wire individual override inputs, each isolated and capable of reading dry contact closures. The inputs shall be self-powered by the controller, the controller shall provide isolated low voltage Class 2 ac power for up to 48 two-wire override switches. Override inputs shall accept two-wire momentary or maintained contact closures from switches and contacts.
3. Hardware Resident Control Software Requirements:
 - a. The controller management functions shall store and manage user-defined and internal controller information such as the number of switches connected, real position of the switch and whether a switch is on or off.
 - b. Inputs shall be user programmable as one of eight configurations:
 1. Demand Accumulation (Demand Metering)
 2. Timed Momentary (Replaces Mechanical "Wind-Up" Timers)
 3. Timed Maintained
 4. Momentary (Toggle ON/OFF Function)
 5. Alarm (Provides Warning Indication)
 6. Maintained (Follow ON/OFF Function)
 7. Network (Inputs are passed over the main operating network)
 8. Local (Inputs remain within the connected controller module)
 - c. It shall be possible to assign time schedules and areas to individual switches. The time schedules shall be user programmable to control the time and the day the switch is active. Each switch shall be able to be assigned to specific areas of control.
4. Manual Switch Override Control shall be accomplished through the central operator's station keyboard, the laptop computer, or a mobile programming device. The operator may toggle individual switches on and off
5. The Switch Override Controller shall contain local, general-purpose, auxiliary control inputs and outputs. As a minimum each controller shall have the following:
 1. Four dry contact digital inputs for use with override switches, occupancy sensors, photocells, meter pulse contacts, or connection to other control systems.

2. Eight universal inputs (analog or digital) for uses with override switches, occupancy sensors, photo sensors, light level override adjustment switches, temperatures, or connection to other control systems.
 3. Sixteen digital outputs for use with status LEDs, pilot relays for auxiliary controls, or connection to other control systems. Switch Override Controller shall be expandable to include an additional 32 digital outputs
 4. Three analog outputs for use with ballast control, auxiliary controls (4-20ma, 0-10v), or connection to other control systems
6. The Input-to-Output Matrix feature shall allow any connected switch to control any load or group of loads in the system

D. ³Telephone Override Control

1. The Telephone Override Control equipment shall be a lighting management controller that will provide a voice prompted method for control of lighting. It shall be possible to override an individual light fixture or group of light fixtures during scheduled or non-scheduled hours using any touch-tone telephone. Up to 120 telephone override controllers per network shall be possible
2. Hardware Requirements:
 - a. There shall be LEDs for indicating the status of the phone line showing ON Hook and OFF Hook.
 - b. The telephone line interface shall be compatible with a standard touch-tone line. Connection to the controller shall be by way of a RJ-11 jack.
3. Hardware Resident Control Software Requirements:
 - a. The controller management functions shall store and manage user-defined and internal controller information such as the tenant load access numbers, load assignments and override times.
 - b. Tenant load access numbers shall be up to 4 digits.
 - c. User authorizations codes shall be up to 4 digits.
 - d. Each telephone override controller shall handle at least 250 unique load access and authorization code combinations.
 - e. Two modes of timed override shall be provided, fixed and variable. The fixed mode shall ignore the user voice prompt and the timed entry and use the maximum on time as the overriding time. The variable mode takes the time entered at the time of the dial-up.
 - f. The maximum time allowed for variable load override shall be 0–9 time intervals. The interval time shall be user defined such as 15 minutes, half hours, hour or two hours. The controller shall also limit number of override intervals. For example, if the interval is one hour and the maximum interval is set to 8, loads assigned to Telephone Override may be overridden from 1 to 8 hours. An assignment of 0 hours shall terminate an active override.
 - g. All load access, authorization codes and override time parameters shall be entered using a system computer or mobile PC.
 - h. Controller configuration shall be protected if there is a power loss. The memory backup will be rated for 10 years

³ Note to Spec. Writer – Optional

- i. The voice prompting shall be capable of up to one minute of speech stored in non-volatile memory
- j. Override events shall be logged as to the time, date, access code and authorization.

E. ³Universal I/O Module Control

1. The Universal I/O Module Control equipment shall be a controller that will provide the ability to interface a variety of general purpose input and output auxiliary control devices. Inputs and outputs shall be low voltage and individually custom programmable. It shall be possible to program any input or output associated it with any load or group of loads in the system. Inputs and outputs shall be capable of being individually time scheduled for different days of the week with no less than 30 holidays. Up to 120 Universal I/O Modules shall be possible per network.
2. Hardware and Software Control Requirements
 - a. The controller shall be powered from a Class 2 ac power source
 - b. There shall be LEDs for indicating the following conditions; normal controller operation, transmit and receive for the network, and power to the controller
 - c. Controller configuration shall be protected if there is a power loss. The memory backup will be rated for 10 years
 - d. When the controller input power drops below normal, the controller shall not lose its programmed information. Upon return of normal power load, position changes scheduled during the power failure period shall immediately be updated to the current scheduled position, or the load returned to the scheduled load position prior to the power failure. No operator interaction shall be required to return the controller to normal
 - e. The controller shall be able to remove itself from the expansion network should it fail. Network "Lock-Ups" due to failed controllers shall not be acceptable
 - f. The stand-alone feature shall permit the controller to operate without a central computer. All the functions such as configuration settings, ON/OFF times, real-time clock, automatic leap year, daylight savings' time adjustments, day/date, month shall be included. The only need the controller shall have for the expansion network is to send and receive global information to and from the intelligent panelboards
 - g. The controller shall maintain an alarm log. This log shall record where the alarm occurred, alarm reason, date and time of the alarm, and log when the alarm was cleared and acknowledged. This log shall be maintained in non-volatile memory. The alarm log shall store up to 300 alarms
 - h. Each controller shall provide the Windows-based control software as an integral part of the controller. The control software shall be hardware resident and provide the ability to construct user-defined control scenarios. It shall be possible to program the controller over the main shielded twisted pair network via the central operator's station. Software shall be able to perform basic grouping, scheduling and assigning functions, and shall be expandable to hold customized screens, or enable secure access to the system through the Internet
 - i. Each controller shall be programmable with up to 50 schedules. Each output may have a 7-day weekly schedule. The controller shall monitor its stored times schedule and set the programmed output values at the programmed times. In addition to time of day scheduling, the panel shall be capable of scheduling from computed sunrise and sunset times (Astronomical).
 - j. Provide each output with the ability to preschedule up to 30 holidays

- k. Each controller shall be locally accessible through a touch-sensitive mobile device such as a Pocket PC. Mobile device shall be capable of performing, through a Windows-based environment, basic maintenance and programming functions. Each panel must be capable of full operation when this device is not present. The device must also be capable of operating software other than the software required for system control
 - l. As a minimum each controller shall have the following:
 - 1. Twelve dry contact digital inputs for use with override switches, occupancy sensors, photocells, meter pulse contacts, or connection to other control systems.
 - 2. Eight universal inputs (analog or digital) for uses with override switches, occupancy sensors, photo sensors, light level override adjustment switches, temperatures, or connection to other control systems.
 - 3. Eight digital outputs for use with status LEDs, pilot relays for auxiliary controls, or connection to other control systems.
 - 4. Three analog outputs for use with ballast control, auxiliary controls (4-20ma, 0-10v), or connection to other control systems
- F. ³Daylight Harvesting Control
- 1. The Daylight Harvesting Control shall be a lighting management controller that will provide the ability to maintain a constant intensity of fluorescent lighting based on a predetermined light level. The Daylight Harvesting Control shall be capable of controlling the Advance Mark VII, 0 to 10 volt dimming electronic ballast (or equivalent), through linear slide dimmers for manual dimming of light level and/or photo dimming sensors. Photo dimming sensors shall sense total light level and provide signal input to the controller for daylight compensation. The daylighting Control controller shall interface with the electronic dimming ballast through a 0 to 10 Vdc input signal.
 - 2. Daylight Harvesting Control shall be associated with auxiliary input and output devices available on any network controller.
 - a. Universal inputs shall be used for photosensor dimming and linear slide dimmers.
 - b. Analog outputs shall be used for direct ballast 0-10v control. An analog output shall be capable of supporting up to 8 ballasts in parallel. (For additional ballasts, a special power driver ballast driver may be required.)
 - 3. Hardware Resident Control Software Requirements
 - a. Controller Functions shall provide function calculations that accept several light sensor values or switch input signals and scale them for a desired output result. The Input control functions shall be any user defined logical or arithmetic function with translates the inputs into the desired ballast output lighting level.
 - b. Ballast control shall be capable of either Open or Closed loop control. Open loop shall operate with its output value as a percentage of its input value. Closed loop shall operate with its output value as a result of its set point and input, and shall regulate the output.
 - c. Ballast controls shall be capable of being associated with load groups to form logical scene control.

³ Note to Spec. Writer – Optional

- d. Manual Ballast Override Control shall be accomplished through the central operator's station keyboard or the laptop computer.

G. Remote Access Control

1. The Remote Access Control equipment shall be a system management controller that will provide programming and monitoring capabilities from a remote location using standard bell type phone lines and/or local Ethernet
2. Hardware Requirements
 - a. The modem shall operate at 56 KB baud and be an FCC certified standard bell modem.
 - b. Ethernet connection shall use industry standard TCP/IP CAT5 connection.
3. Hardware Resident Control Software Requirements

The controller management functions shall store and manage user-defined and internal controller information such as the access codes, IP address, modem parameters and number of rings to answer.

H. ³Network Interface Protocols

1. ³Each system shall have the capability to provide status and control information to a separate network using BACnet protocol
2. ³Each system shall have the capability of using local Ethernet network as a backbone for lighting controller network communications
3. Each system shall have the capability to provide status and control information to other computers using Ethernet XML/SOAP protocol
4. ³System operator computer shall be capable of providing status and control information to other computer programs via DDE and/or OPC.
 - a.

2.05 SYSTEM OPERATOR'S EQUIPMENT REQUIREMENTS

- A. The System Operator's Equipment shall consist of Windows-based programming and monitoring screens and a Central Operator's Station that shall function as the central point for data manipulation and programming of the Lighting Control System. The Central Operator's Station shall be connected to the main shielded twisted pair network through a network interface. It shall be possible to have more than one Central Operator's Station per system. The Central Operator's Station shall consist of an IBM compatible personal computer with an optional internal network interface printer and system programming and monitoring screens.
- B. The Central Operator's Station shall be located in an area relatively free of moisture, dust and harsh environments.
- C. Central Operator's Station Hardware Requirements:
 1. System Unit –1.0 GHz Pentium III Microtower
 2. Hard Drive – 40 GB
 3. Floppy Drive – 3.5-inch
 4. Ram Memory – 128 MB

³ Note to Spec. Writer – Optional

5. Integrated Intel – 3D AGP
 6. CD-Rom – 48 x 20 x CD-ROM
 7. Modem – 56 KB
 8. USB – Port 1
 9. Monitor – 15-inch CRT, NI, Digital
 10. Parallel Port – 1, Printer
 11. Serial Port – 1, RS-232
 12. Mouse Port – 1
 13. Keyboard – 101-Key SpaceSaver
 14. Disk Operating System – Windows 98, 2000, ME
 15. Mouse – 3 Button
- D. Data Logging Printer Minimum Hardware Requirements
1. 600 x 300 dpi
 2. 6 PPM
 3. Printer cable
- E. Operator Interface Software Minimum Requirements
1. The Operator Interface shall be Microsoft Windows-based and provide a graphical environment that dynamically interacts with the Central Operator's Station programming screens. The operator interface shall be able to run more than one software program at a time, transfer information between them, and organize and manage files. The software shall provide a consistent graphics interface for the operator
- F. Central Operator's Station Minimum Programming Screen Requirements
1. The Central Operator's Station Programming Screens shall provide a fully interactive easy-to-use software program for programming and monitoring power switching, lighting control, energy control and system management equipment. Each software program shall be a Windows application. Consistencies with Windows software such as pull-down menus, dialog boxes, icons, etc. shall be maintained. The programming screens, as a minimum, shall provide access to all the capabilities that exist in the control equipment. The programming screens shall provide an operator friendly method of programming and monitoring all system functions including, management of various data generated by the system
 2. Power Switching Equipment Programming Screens Minimum Requirements
 - a. Date and Time
 - b. Time-of-Day On/Off Scheduling
 - c. Holiday Scheduling
 - d. Astronomical Scheduling
 - e. Manual Override
 - f. Alarms
 - g. Occupant Warning
 - h. Hardware Diagnostics
 - i. Panel Descriptions
 - j. Load Descriptions

- k. Panel Address
 - l. Input-to-Output Matrixing
 - m. Security Access Codes
3. ³Lighting Control Equipment Programming Screens Minimum Requirements
 - a. ³Switch Overrides
 - b. ³Voice Prompted Telephone Override
 - c. ³Daylight Harvesting
 - d. ³Remote System Access
 4. ³System Management Equipment Programming Screens Minimum Requirements
 - a. Historical Data Logging
 5. ³Building Graphics Software Requirements
 - a. The Building Graphics Software shall provide a fully interactive object oriented graphics interface for controlling the Lighting Control system. It shall be possible to create and depict objects such as light fixtures, switches, occupancy sensors, light sensors, floor plans, etc.
 - b. ³ The Graphics Software shall provide server graphic web pages over local Ethernet connection to any computer using a standard Internet Browser,
 6. ³Software shall be available to allow the system to be accessed through the Internet through a secure line. Software is to reside on owner-provided server. Software shall provide security to the system
 7. ³Historical Data Logging Software
 - a. General Equipment Overview: The Historical Data Logging equipment shall be a system management controller that will allow the monitoring and storing of user-defined system and load actions. The user-defined actions shall be divided into three categories: load changing events, system events and monitoring events. The load changing events shall date and time stamp the logging of a load changing state. The system event shall date and time stamp the logging of system alarms and failures, and list the reason for the system failure. The monitoring logger at defined intervals shall take snapshots of various system parameters, system parameters shall be, but not limited to, load cycle counts or load on times. It shall be possible to download these logging actions to the Central Operator's Station. The Central Operator's Station shall poll the data logging controllers and download controller logging information.
 - b. Hardware Resident Control Software Requirements
 1. Each lighting controller shall provide data logging software as an integral part.
 2. The data logging functions shall be divided into three functions: load logging, system logging and time interval monitoring.
 3. The load logging function shall monitor load changes and be capable of storing 1,000 load state changes. Changes shall be logged by load changed, time and date
 4. The system logging function shall record system-related events , these events shall be the alarms generated by the panelboards, lighting management and system management controllers. The date and time of the action, when the

³ Note to Spec. Writer – Optional

action occurred, when acknowledged and when cleared shall be stored.

Controllers shall have the capacity to store 500 alarm actions. It shall be possible for the controller to be polled by the central operator's station and download controller logging information to the station.

5. The time interval function shall be capable of taking snapshots of local network-wide parameters. These parameters shall be load states, energy levels and demand levels. These parameters shall be stored with a time and date stamp. A user-definable rate of sampling shall be assignable to each parameter. It shall be possible to log all loads by user selection. A snapshot of the states of all the loads connected to a controller, and the duration of time the loads have been on, shall be stored along with the date and time of the sampling. It shall be possible for the user to define the time that the sampling begins and ends and the time interval to sample. Up to a maximum of 1,000 samples may be stored. It shall be possible to log up to 500 network transmitted energy level samples from the low voltage switch override controller energy accumulators. It shall be possible to log up to 500 network transmitted demand level samples from the peak kW demand controller. It shall be possible for the central operator's station to poll the controller and download controller historical logging information to the central operator's station.
8. [∩]Data Management Software Requirements
 - a. The Data Control Software shall provide electronic spreadsheet software for managing and presenting data accumulated by the Lighting Control System in the Windows environment. The operator interface shall be easy-to-use providing help screens, customizable smart icons, function menu, worksheet navigator, tabs for named worksheets, interactive status bar, drag-and-drop moving and copying of data, database querying, spelling checker, scenario and auditing tools, macro commands, charting, drawing, and database features. Standard spreadsheet reports shall be able to provide for Tenant Billing, Power Usage, Fixture Life, Alarms, and Daylight Harvesting. Standard spreadsheet reports shall be able to be custom tailored by the operator.
 - b. Software Requirements
 1. It shall be possible to create a visual representation of worksheet data, the worksheet data shall be dynamic when required and update the trend chart as data changes. It shall be possible to create 3D bar, line, area, pie charts and High-Low-Close-Open (HLCO) charts to track data that fluctuates over time, such as kW usage, demand trends, etc.
 2. Custom reports shall be possible; a standard tenant billing format shall be provided with the capability to be modified for custom billing requirements.
 3. Provide the ability to prevent others from changing or opening a file containing confidential data.
 4. Provide the ability to collect, organize and interpret numeric data.
 5. Provide the ability to share information across applications by making a DDE connection between a file in one Windows application and a file in another Windows application.
 9. Software Requirements

[∩] Note to Spec. Writer – Optional

- a. Provide the ability for objects and groups of objects to be moved, sized and animated.
- b. It shall be possible to run two or more Windows applications on the same screen simultaneously.
- c. Provide process data by way of Dynamic Data Exchange (DDE) to other Windows applications for custom management reporting, etc.
- d. Support discrete, real values, integers and strings. No limit shall be placed on the number of each type. The total number of points available shall be 32,767.
- e. Built-in objects shall allow easy creation of real-time or historical trend displays. Four pens per chart shall be provided. There shall be no limit on the number of charts per screen or per application. Multiple displays shall be simultaneously supported.
- f. Provide the ability to display up to four pens at a time in historical trend charts. Provide runtime tag name selection, zooming, scrolling, centering capabilities, log to disk, screen display and printing capabilities. Export data to Microsoft Excel, text files or any DDE program.
- g. Alarms shall be easy to configure and prioritize. Provide for 1-999-alarm priorities and alarm color changes according to alarm status. Provide support of hierarchical alarm groups to eight levels, with each alarm group having up to 16 levels. There shall be no limit on the number of alarms. Alarms shall be displayed on screen and/or logged to a printer. Allow individual selection of formats for display, disk logging or printing. The alarm display shall allow viewing of all alarms or any subset either as alarm summary or history.
- h. Provide the ability to select any pointing device supported by Windows, mouse, trackball, touch screen, light pen, etc.
- i. Logical and mathematical expressions shall be supported. Provide the ability to use single precision floating point numbers. Internal calculations shall use double precision floating point numbers.
- j. Provide extensive action scripting capability for rapid prototyping, background calculations, and simulation. Action scripts may be invoked on data change, conditions (on True, on False, while True, while False) Button (on Button Down, while one Button Up) of Windows being opened, closed or while open; when data changes value; upon operator actions such as depressing buttons or selecting other objects; or as the result of alarm conditions.
- k. Provide Built-in Log-on, assignable levels.
- l. Provide object-oriented design tools for easy drawing, arranging, aligning, layering, spacing, rotating, inverting, duplicating, cutting, copying, pasting, erasing, etc.
- m. Provide animation links that may be used singly or in combinations to provide complex size, color movement, and/or position changes. Discrete, analog and string touch inputs; horizontal and vertical sliders; discrete and action pushbuttons; show and hide window pushbuttons; line, fill and text color links for discrete and analog values and alarms; object height and width links; vertical and horizontal position links; vertical and horizontal percent fill links; visibility links; discrete, analog and string value output links, rotation links and blink links.
- n. Provide the ability to poll only points which appear on screen, alarm points, historically logged points or points in background logic.
- o. Provide complete screen and database documentation printing.
- p. Provide the ability to start and control other applications.

- q. Provide the ability to design and generate custom reports.

PART 3 EXECUTION

3.01 FACTORY TESTING

- A. The factory service shall provide adequate testing of the supplied equipment and software to ensure that the system performs as intended by the specification. Building engineering personnel shall be trained on all aspects of operating and maintaining the system. Care shall be taken to ensure that the system load connections are to the electrical drawing and that the control scenarios are operating properly.

3.02 FIELD QUALITY CONTROL

- A. Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in starting-up and programming the system for a period of _____ working days. The manufacturer's representative shall be factory-trained and shall have a thorough knowledge of the software, hardware and system programming. The manufacturer's representative shall provide the following services:
 - 1. Check installation of all smart panelboards, expansion cabinets and the central operator's station
 - 2. Test operation of all remote-controlled loads
 - 3. Test operation of all application-specific controllers
 - 4. Test operation of all telephone override phone lines
 - 5. Test operation of all network connections
 - 6. Test operation of central operator's station and associated printer
 - 7. Install central control software and test operation
 - 8. Repair or replace any defective component
 - 9. Test operation of complete lighting control system
 - 10. Conduct system point-by-point walk through
- B. The Contractor shall provide three (3) copies of the manufacturer's field startup.
- C. The following system programming shall be provided by the factory trained manufacturer's representative:
 - 1. Assist the owner in developing a practical control scenario for each application
 - 2. Program the owner supplied control scenario
 - 3. Explain the operation of the control programs to the owner and walk through their operation
 - 4. Provide programs on 3.5-inch diskette or CD-ROM or both
 - 5. Maintain 3.5-inch diskette or CD-ROM copy of programmed information at factory (as of the startup date or when changes are provided by the owner)

3.03 MANUFACTURER'S CERTIFICATION

Note to Spec. Writer – Insert data in blanks

- A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.
- B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification.

3.04 TRAINING

- A. The Contractor shall provide a training session for up to five (5) owner's representatives for _____ normal workdays at a jobsite location determined by the owner.
- B. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the control system, programming, and other major components.
- C. The training program shall include:
 - 1. System review of all system components and their function
 - 2. System review of all management software and its function
 - 3. Operator training to develop experience with control applications.

3.05 DOCUMENTATION

- A. Documentation shall be provided as indicated below:
 - 1. System 1 - Line Diagram: Show system components and quantities including smart panelboards, expansion cabinets, switches, light sensors, data line, telephone override connection and central operator's station network connection
 - 2. Panelboard Load Schedule: Show load placement and sizing
 - 3. Panelboard Wiring Schedule: Show load terminations
 - 4. Wiring Diagrams: Show typical interconnect wiring diagram for each system component supplied
 - 5. Installation Guide: Provide instructions on how to install system components
 - 6. Manual: Provide System User's Guide and Programmer's Guide in loose leaf three-ring binders
 - 7. Training Video: The contractor shall provide a complete training video for installation of software, basic operation of software, and common components of system
 - 8. Riser Diagram: Provide single line drawing showing control connections for each system component

3.06 INSTALLATION

- A. The Contractor shall furnish, install and terminate all communication conductors and associated conduits external to any factory supplied equipment.
- B. All communication conductor wiring and routing shall be per the manufacturer's recommendations and as shown on the contract drawings.

3.07 FIELD TESTING

Note to Spec. Writer – Insert data in blanks

- A. Verify complete system operation including all hardware, software and communication devices.
- B. Verify networking performance with all interfacing systems by other manufacturers.

3.08 WARRANTY

- A. The warranty shall ensure that the Lighting Control System manufactured and supplied as specified will be the kind and quality described in the specification and will be free of defects in workmanship and material.
 - 1. Warranty shall be 1 year from date of startup not to exceed 18 months from date of shipment
 - 2. Warranty shall be valid if startup is completed by factory-trained representative
 - 3. Warranty replacement parts shall be available on a 24-hour delivery basis, if requested during normal working hours
 - 4. Warranty shall provide for on-site technical assistance if deemed necessary