SECTION 26 09 33
DIMMING CONTROL

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Contractor shall furnish all equipment, labor, and other services necessary for the proper installation of the devices as indicated on the drawings and herein specified.

1.2 SUBMITTALS

A. Submit manufacturer's standard catalog data giving all application, wiring, and installation information on components and sub-systems.

B. Provide test data and/or samples as required to demonstrate conformance with PART 2 – PRODUCTS of this specification.

1.3 QUALITY ASSURANCE

A. Manufacturer shall have a minimum of 10 years continuous experience in manufacturing architectural lighting control products.

B. All devices shall be U.L. and CSA Listed specifically for the required loads (i.e., incandescent, fluorescent, magnetic low voltage transformer). Manufacturer shall provide file card upon request. Universal- type dimmers shall not be acceptable.

1.4 PROJECT CONDITIONS

A. Do not install equipment until conditions can be maintained in spaces to receive equipment at an ambient temperature of 0 degrees Celsius (32 degrees Fahrenheit) to 40 degrees Celsius (104 degrees Fahrenheit) and a maximum of 90% non-condensing relative humidity.

B. Lighting control system must be protected from dust during installation.

C. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver system components individually wrapped in factory-fabricated containers unless otherwise noted.

B. Include installation, programming, and maintenance instructions.

C. Handle system components carefully to prevent breakage, denting and scoring of finish. Do not install damaged system components; replace and return damaged units to equipment Manufacturer.

D. Store system components in clean, dry space. Store in original cartons and protect from dirt, physical damage, weather, and construction traffic until ready for installation

1.6 WARRANTY AND WARRANTY SERVICE

A. Unless otherwise noted, the manufacturer shall provide a two-year warranty on the complete system for all systems with factory commissioning (cooling fans shall have 8-year warranty). Warranty shall cover 100 percent of the cost of the manufacturer's services and any replacement parts required over the first two years which are directly attributable to the manufacturer.

B. Warranty coverage shall begin from date of final system commissioning or three months from date

of delivery, whichever is the earlier. Commissioning and warranty service shall be performed by a factory-trained engineer.

1.7 MAINTENANCE

A. Make ordering of new equipment for expansions, replacements, and spare parts available to end-user, qualified dealer or installer.

B. Make new replacement parts available for minimum of 10 years from date of manufacture.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acuity nLight system as design basis.

B. Acceptable: Lutron, Wattstopper, Crestron, Greengate

C. The listing of a manufacturer in the document as “acceptable” does not assure acceptance. It is the sole responsibility of the electrical contractor to ensure that any price quotations received and submittals made are for devices that meet or exceed the specifications included herein.

2.2 DISTRIBUTED / LOCAL DIMMING CONTROL (NLIGHT)

A. System shall have an architecture that is based upon three main concepts; 1) intelligent lighting control devices 2) standalone lighting control zones 3) network backbone for remote or time based operation.

B. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.

C. System must interface directly with intelligent LED luminaires such that only CAT-5 cabling is required to interconnect luminaires with control components such as sensors and switches (see *Networked LED Luminaire* section)

D. Intelligent lighting control devices shall communicate digitally, require <4 ma of current to function (Graphic wall stations excluded), and posses RJ-45 style connectors.

E. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher level network backbone.

F. Devices within a lighting control zone shall be connected with CAT-5e low voltage cabling in any order.

G. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.

H. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.

I. Power for devices within a lighting control zone shall come from either resident devices already present for switching (relay device) or dimming purposes, or from the network backbone. Standalone “bus power supplies” shall not be required in all cases.

J. All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e. Not in a remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized

or remote switching shall be capable of being accommodated.

K. System shall have one or more primary wall mounted network control “gateway” devices that are capable of accessing and controlling connected system devices and linking into an Ethernet LAN.

L. System shall use “bridge” devices that route communication and distribute power for up to 8 directly connected lighting zones together for purposes of decreasing system wiring requirements.

M. System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control profiles.

N. Individual lighting zones shall be capable of being segmented into several “local” channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.

O. System shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a spaces sequence of operation according to a time schedule so as to enable customized time-of-day, day-of-week utilization of a space. Note operating modes should be utilized only in manners consistent with local energy codes.

1. Auto-On / Auto-Off (via occupancy sensors)
2. Manual-On / Auto-Off (also called Semi-Automatic)
3. Manual-On to Auto-On/Auto-Off
4. Auto-to-Override On
5. Manual-to-Override On
6. Auto On / Predictive Off

P. An application that runs on “smart” handheld devices (such as an Apple® iphone®) shall be available for personal lighting control.

Q. A taskbar style desktop application shall be available for personal lighting control.

R. Control software shall enable logging of system performance data and presenting useful information in a web-based graphical format and downloadable to .CSV files.

S. Control software shall enable integration with a BMS via bacnet IP.

T. System shall provide the option of having pre-terminated plenum rated CAT-5 cabling supplied with hardware.

2.3 INDIVIDUAL DEVICE SPECIFICATIONS

A. Gateway Control Module (ngwy2)

1. Control module shall be a device that facilitates communication and time-based control of downstream network devices and linking into an Ethernet.
2. Devices shall have a user interface that is capable of wall mounting, powered by low voltage, and have a touch screen.
3. Control device shall have three RJ-45 ports for connection to other backbone devices (bridges) or directly to lighting control devices.
4. Device shall automatically detect all devices downstream of it.
5. Device shall have a standard and astronomical internal time clock.
6. Device shall have one RJ-45 10/100 BaseT Ethernet connection.
7. Device shall have a USB port
8. Each control gateway device shall be capable of linking 1500 devices to the management software.
9. Device shall be capable of using a dedicated or DHCP assigned IP address.

B. Networked system occupancy sensors

1. Occupancy sensors system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
2. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state; thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
3. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional “dual” technology shall be used.
4. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable.
5. All sensing technologies shall be acoustically passive meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.
6. Sensors shall be available with one or two occupancy “poles”, each of which provides a programmable time delay.
7. Sensors shall be available in multiple lens options which are customized for specific applications.
8. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
9. All sensors shall have two RJ-45 ports or capable of utilizing a splitter.
10. All sensors shall have the ability to detect when it is not receiving valid communication (via CAT-5 connections) and blink its LED in a pattern to visually indicate of a potential wiring issue
11. Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.
12. Sensors shall be able to function together with other sensors in order to provide expanded coverage areas by simply daisy-chain wiring together the units with CAT-5 cabling.
13. Sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements.
14. Wall switch sensors shall recess into single-gang switch box and fit a standard GFI opening.
15. Wall switch sensors must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.
16. Wall switch sensors shall have optional features for photocell/daylight override, vandal resistant lens, and low temperature/high humidity operation.
17. Wall switch sensors shall be available in four standard colors (Ivory, White, Light Almond, Gray)
18. Wall switch sensors shall be available with optional raise/lower dimming adjustment controls
19. Network system shall also have ceiling, fixture, recessed, and corner mounted sensors available.

20. Fixture mount sensors shall be capable of powering themselves via a line power feed.
21. Sensors shall have optional features for photocell/daylight override, dimming control, and low temperature/high humidity operation.

C. Networked System Daylight (Photocell and or Dimming) Sensors

1. Photocell shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
2. Photocell and dimming sensor's set-point and deadband shall be automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.
3. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
4. Dimming sensors shall control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of class 2 current (typically 40 or more ballasts).
5. Photocell and dimming sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements. (Note: This function should be performed prior to any dimming of the lamps including the "auto set-point" setting.)
6. Combination units that have all features of on/off photocell and dimming sensors shall also be available.
7. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The second zone shall be capable of being controlled as an "offset" from the primary zone.

D. Networked system power (relay) packs

1. Power Pack shall incorporate one or more Class 1 relays and contribute low voltage power to the rest of the system. Primary Dimming Power Packs shall incorporate the relay(s) and allow for 0-10 VDC dimming output. Secondary Power Packs will allow for phase-controlled dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.
2. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system.
3. All devices shall have two RJ-45 ports.
4. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.
5. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
6. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.

7. Primary Power Packs shall be capable of switching a 20A circuit, de-rated to 16A.
8. Primary Dimming Power Packs shall be capable of switching a 20A circuit, de-rated to 16A, and dimming 100mA of 0-10V DC control current.
9. Secondary Power Packs shall be available that provide up to 5 Amps dimming of phase-controlled loads.
10. Specific Power/Dimming Power Packs shall be available that are UL924 listed for switching/dimming of Emergency Power circuits.

E.Networked System Relay and Dimming Panels (npanel4)

1. Panel shall incorporate up to 4 normally closed latching relays capable of switching 120/277 VAC or up to 2 Dual Phase relays capable of switching 208/240/480 VAC loads.
2. Relays shall be rated to switch up to a 30A ballast load at 277 VAC.
3. Panel shall provide one 0-10VDC dimming output paired with each relay.
4. Panel shall power itself from an integrated 120/277 VAC supply.
5. Panel shall be capable of operating as either two networked devices or as one.
6. Panel shall supply current limited low voltage power to other networked devices connected via CAT-5.
7. Panel shall provide auxiliary low voltage device power connected wired directly to a dedicated terminal connection

F.Networked auxiliary input / output (i/o) devices

1. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½" knockout.
2. Devices shall have two RJ-45 ports
3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
4. Specific I/O devices shall have a dimming control output that can control 0-10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current (typically 40 or more ballasts).
5. Specific I/O devices shall have an input that read a 0-10 VDC signal from an external device.
6. Specific I/O devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event, run a local/remote control profile, or raise/lower a dimming output
7. Specific I/O devices shall sense state of low voltage outdoor photocells
8. Specific I/O devices shall enable RS-232 communication between lighting control system and Touch Screen based A/V control systems.

G.Networked system wall switches and dimmers

1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
2. Devices shall be available with zero or one integrated Class 1 switching relay.
3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
4. All sensors shall have two RJ-45 ports.
5. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.
6. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
7. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
8. Devices shall have mechanical push-buttons, and shall be made available with custom button labeling.

H. Networked system graphic wall station

1. Device shall have a 3.5” full color touch screen for selecting up to 8 programmable lighting control presets or acting as up to 16 on/off/dim control switches.
2. Device shall enable configuration of lighting presets, switched, and dimmers via password protected setup screens.
3. Device shall enable user supplied .jpg screen saver image to be uploaded.
4. Device shall surface mount to single-gang switch box
5. Device shall have a micro-USB style connector for local computer connectivity.
6. Device shall have two RJ-45 ports for communication

I. Networked system scene controllers

1. Device shall have two to four buttons for selecting programmable lighting control profiles or acting as on/off switches.
2. Device shall recess into single-gang switch box and fit a standard GFI opening.
3. Devices shall provide LED user feedback.
4. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
5. All sensors shall have two RJ-45 ports.
6. Device shall be capable of reprogramming other devices in its zone so as to implement user selected lighting scene.
7. Device shall be capable of selecting a lighting profile be run by the system’s upstream Gateway so as to implement selected lighting profile across multiple zones (and not just its local zone).
8. Device shall have LEDs indicating current selection.

J. Communication bridges

1. Device shall surface mount to a standard 4” x 4” square junction box.
2. Device shall have 8 RJ-45 ports.
3. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to Control Gateway.
4. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a CAT-5 cabled connection.
5. Device shall be careful of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.

2.4 LIGHTING CONTROL PROFILES

A. Changes to the operation of the system shall be capable of being made in real-time or scheduled via lighting control profiles. These profiles are outlines of settings that direct how a collection of devices function for a defined time period.

B. Lighting control profiles shall be capable of being created and applied to a single device, zone of devices, or customized group of zones.

C. All relays and dimming outputs shall be capable of being scheduled to track or ignore information regarding occupancy, daylight, and local user switches via lighting control profiles.

D. Every device parameter (e.g. Sensor time delay and photocell set-point) shall be configurable via a lighting control profile.

E. All lighting control profiles shall be stored on the network control gateway device and on the

software's host server.

F. Lighting control profiles shall be capable of being scheduled to run according to the following calendar options: start date/hour/minute, end date/hour/minute, and sunrise/sunset +/- timed offsets.

G. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.

H. Daylight savings time adjustments shall be capable of being performed automatically, if desired.

I. Lighting control profile schedules shall be capable of being given the following recurrence settings: daily, weekday, weekend, weekly, monthly, and yearly.

J. Software shall provide a graphical tool for easily viewing scheduled lighting control profiles.

2.5 MANAGEMENT SOFTWARE

A. Every device parameter (e.g. Sensor time delay and photocell set-point) shall be available and configurable remotely from the software

B. The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current PIR Status, current Microphonics Status, remaining occupancy time delay(s), current photocell reading, current photocell inhibiting state, photocell transitions time remaining, current dim level, device temperature, and device relay state(s).

C. The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.

D. A printable network inventory report shall be available via the software.

E. A printable report detailing all system profiles shall be available via the software.

F. Software shall require all users to login with a User Name and Password.

G. Software shall provide at least three permission levels for users.

H. All sensitive stored information and privileged communication by the software shall be encrypted.

I. All device firmware and system software updates must be available for automatic download and installation via the internet.

J. Software shall be capable of managing systems interconnected via a WAN (wide area network)

2.6 BMS COMPATIBILITY

A. System shall be capable of providing a bacnet IP gateway as required for the project.

2.7 SYSTEM ENERGY ANALYSIS AND REPORTING SOFTWARE

A. System shall be capable of reporting lighting system events and performance data back to the management software for display and analysis.

B. Intuitive graphical screens shall be displayed in order to facilitate simple viewing of system energy performance.

C. An "Energy Scorecard" shall be display that shows calculated energy savings in dollars, kwhr, or CO_2.

D. Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photocells, manual switching, etc).

E. Energy savings data shall be calculated for the system as a whole or for individual zones.

F. A time scaled graph showing all relay transitions shall be presented.

G. A time scaled graph showing a zones occupancy time delay shall be presented

H. A time scaled graph showing the total light level shall be presented.

I. User shall be able to customize the baseline run-time hours for a space.

J. User shall be able to customize up to four time-of-day billing rates and schedules.

K. Data shall be made available via a .CSV file

2.8 START-UP AND SUPPORT FEATURES

A. To facilitate start-up, all devices daisy-chained together (using CAT-5) shall automatically be grouped together into a functional lighting control zone.

B. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.

C. Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.

D. All system devices shall be capable of being given user defined names.

E. All devices within the network shall be able to have their firmware reprogrammed remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.

F. All sensor devices shall have the ability to detect improper communication wiring and blink its LED in a specific cadence as to alert installation/startup personnel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. It shall be the responsibility of the Electrical Contractor to receive and store the necessary materials and equipment for installation of the dimmer system. It is the intent of these specifications and plans to include everything required for proper and complete installation and operation of the dimming system, even though every item may not be specifically mentioned. The contractor shall deliver on a timely basis to other trades any equipment that must be installed during construction.

B. The electrical contractor shall be responsible for field measurements and coordinating physical size of all equipment with the architectural requirements of the spaces into which they are to be installed.

C. The electrical contractor shall install all lighting control and dimming equipment in accordance with manufacturers approved shop drawings.

D. All branch load circuits shall be live tested before connecting the loads to the dimmer system load terminals.

E. Electrical Contractor to provide factory supplied uninterruptable power supply (UPS) capable of powering central lighting control system processor for a minimum of 30 minutes. UPS to be configured to automatically and safely shut down processor after 20 minutes of power outage.

F. Equipment shall be installed utilizing manufacturer's shop drawings and in accordance with these specifications.

G. The Electrical Contractor shall run separate neutrals for all branch load circuits.

H. Provide 120v circuit to each controller as needed, for control power.

I. The Electrical Contractor shall define each dimmer's load type, assign each load to a zone, and set control functions.

J. Where a dimming panel is indicated and upon completion of the installation and prior to removal of the bypass jumpers, the Electrical Contractor shall completely test all line voltage power and low-voltage control wiring for continuity and accuracy of connections. The jumpers shall remain in place until all loads have been fully tested and found to be free of mis-wires, short circuits, or other wiring defects.

K. Manufacturer shall provide access to qualified personnel able to address problems with the dimming system 24 hours per day, 365 days per year.

3.2 MANUFACTURER'S SERVICES

A. Upon completion of the installation, including testing of load circuits, the contractor shall notify the dimming system manufacturer that the system is available for formal checkout.

B. The manufacturer of the lighting controls system shall provide trained commissioning personnel for up to six 12 hour time periods for complete initial programming and commissioning of the lighting controls system. Hours of availability shall not be restricted to normal working hours. During this time, the dimming system shall be programmed to operate per the following sequence of operations and according to any additional input provided by the owner, electrical engineer, or lighting designer. Manufacturer to notify lighting designer, electrical engineer, and owner three weeks prior to site visit for system commissioning. All parties are to be present during the system commissioning and shall provide direct input to the commissioning agent for scene settings in all scene controlled spaces, as well as verification of occupancy based functionality, timeclock and photocell settings, etc.

C. Notification shall be provided in writing, two weeks prior to the time that factory-trained personnel are needed on the job site.

D. No power is to be applied to the dimming system unless specifically authorized by written instructions from the manufacturer.

E. The purchaser shall be liable for any return visits by the factory engineer as a result of incomplete or incorrect wiring.

F. Upon completion of the formal check-out, the factory engineer shall demonstrate operation and maintenance of the system to the owners representatives. Training shall not exceed one full working day (minimum of 8 hours). Additional training shall be available upon request.

G. After completion of staff training the manufacturer of the lighting control system shall provide personnel for up to two 8 hour time periods upon request from the building ownership for any necessary changes, updates, or modifications to the lighting controls system settings as deemed necessary by the building ownership after having inhabited and used the space. This time may also be used for additional maintenance staff training if deemed necessary by the building ownership.

3.3 WARRANTY

A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of two years from date of delivery.

B. Warranty shall cover repair or replacement of such parts determined defective upon inspection.

C. Warranty does not cover any product or part of a product subject to accident, negligence, alteration, abuse or misuse. Warranty does not cover any accessories or parts not supplied by the manufacturer.

D. Warranty shall not cover any labor expended or materials used to repair any equipment without manufacturers prior written authorization

3.4 COMMISSIONING

A. Upon completion of the installation, the system shall be completely commissioned by a factory-trained engineer. The commissioning will be performed upon notification by the Electrical Contractor that the system installation is complete and that all loads have been tested live for continuity and freedom from defects and that all control wiring has been connected and checked for proper continuity. A minimum of four site visits shall be made to ensure proper system installation and operation.

1. The first visit shall consist of a prewire inspection to review:
   a. All low voltage wiring requirements.
   b. Separation of power and low voltage/data wiring.
   c. Wire labeling.
   d. Information required on load schedules.
   e. Dimmer/Switching panel locations and installations.
   f. Control locations and addressing.
   g. Computer jack locations.
   h. Load circuit wiring.
   i. Analog phone line and network wiring requirements
   j. Connections to “equipment by others”.

2. The second visit shall be upon completion of the installation of the lighting control system to review:
   a. Verification of the proper connection of power feeds and load circuits.
   b. Verification of proper connection and location of all controls (according to manufacturer’s control schedule).
   c. Energize processor panel and download system data program.
   d. Verify proper connection of panel links (low voltage/data) and address panel.
   e. Download system panel data to dimming/switching panels.
   f. Check dimming panel load types and currents and remove by-pass jumpers.
   g. Verify system operation control by control, circuit by circuit.
   h. Verify proper operation of manufacturers interfacing equipment.
   i. Verify proper operation of manufacturers supplied PC and installed programs.
   j. Verify operation of PC modem/internet connection and test access.
   k. Configure initial groupings of ballasts for wall controls, daylight sensors, and occupant sensors.
   l. Initial calibration of sensors.
   m. Obtain sign-off on system functions.

3. During the third visit, manufacturer shall provide a factory-trained engineer to meet with the Lighting Designer during aiming of lighting fittings and setting of dimming levels, at a time to be coordinated by the General Contractor. The factory-employed engineer, shall remain on the job site for the duration of the Lighting Designer’s site visit, and be available to the Lighting Designer, at all times.
4. During the fourth visit, the factory-trained engineer shall demonstrate and educate the owner’s representative(s) on the system capabilities, operation and maintenance. Allow a minimum of four hours for this on-site “hands-on” instruction.

The Contractor shall provide sufficient personnel to provide adequate operations and maintenance training for all aspects of the systems to the Owner.

a. During this “instruction” session, the systems shall be programmed and fully documented to display lighting scenes programmed during visit three. Contractor shall coordinate this “instruction session” requirement with the appropriate AFI personnel to assure that proper personnel will be in attendance and that sufficient information will be available to set up the programs.

B. Provide both the manufacturer and the Architect with ten working days’ notice of the scheduled commissioning date(s).

3.5 FIELD SUPPORT

A. Start-up, tests, instruction, and documentation

1. Provide the services of the dimming equipment manufacturer's representative for the requirements listed below, as necessary.
2. The entire system shall be tested and adjusted under the supervision of the Contractor.
   a. Program all control functions as needed to verify proper operation. Coordinate all optional features of all systems with the Owner and set up all systems as needed for this specific installation.
   b. Any defects or abnormalities shall be corrected at once and the test re-conducted to demonstrate proper operation.
   c. Submit a signed statement by the manufacturer's field representative that the systems are installed and operating correctly.
3. Provide an electronic copies of maintenance instructions, system/component data sheets and operating instructions and delivered to the Architect.
   a. Preface the systems manual with a typewritten sheet in a plastic protector identifying the system installer by business name, address and telephone number. The technical support service number of the system equipment manufacturer shall be provided and all information pertaining to its usage shall be displayed.
   b. The manuals shall include all approved submittal information, product data sheets, spare parts list, trouble-shooting guides, complete “as-built” and one-line diagrams, circuit diagrams and wiring destination schedules necessary for the proper operation and servicing of the system. Provide an index to all material and indexing dividers for easy location of information.

END OF SECTION