PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Digital-Network Lighting Controls - 26 09 43.13
   2. Addressable Fixture Lighting Control – 26 09 43.16

B. RELATED DOCUMENTS
   1. [Wiring Devices – 26 27 26]
   2. [Lighting Control Devices – 26 09 23]
   3. [Interior Lighting Fixtures – 26 51 13]
   4. [Monitoring and Control of Electrical Equipment – 25 56 00]
   5. [Integrated Automation - 25 00 00]
   6. [Integrated Automation Definitions - 25 06 11]
   7. [Client-Server Information Database Integration - 25 12 23]

1.2 REFERENCES

A. National Fire Protection Association (NFPA)

B. UL Listing/Certification
   1. Certified as Energy Management Equipment (UL 916)
   2. Certified as Emergency Lighting Equipment (UL 924)
   3. Meet Heat and Smoke Release for Air-Handling Spaces (UL 2043)

C. Federal Communications Commission (FCC) / Industry Canada (IC)

D. California Energy Commission (CEC)

E. Local Building Codes

1.3 SYSTEM DESCRIPTION

A. Lighting Control System architecture shall facilitate remote configuration, monitoring, and reporting via a computer software interface. System shall include the following types of control components:
   1. All lighting system equipment shall be networked together, enabling communication between devices to provide a fully engineered solution.
   2. The system architecture shall be capable of distributed intelligence, wherein stand-alone groups of devices shall function according to local automatic sensing or manual control capacity, even if network connectivity to the system is lost.
   3. Drivers/Ballasts: Shall be industry standard, non-proprietary devices that rely on 0-10V for communication and control.
   4. Occupancy/Photosensors: Shall be low voltage that carry 0-10V control signals for communication. Wireless may be acceptable if there is a benefit in specific areas, as approved by the Owner.
1.4 SUBMITTALS

A. Bill of Materials: Complete list of all parts needed to fully install selected system components.

B. Product Data: For each type of product indicated.

C. A paragraph-by-paragraph specification compliance report indicating compliance for each numbered paragraph. The following format shall be used in completing the compliance report:
   1. Comply—without exception.
   2. Qualify—meet the functional intent. For each paragraph, the contractor shall identify all differences in specific functions stated in the given paragraph and provide a description of what is excluded or how the qualifying system will meet the function specified.
   3. Does not comply—cannot meet specified function.
   4. Does not apply – not used or not required.

D. List all software features that can be performed in Native Lighting Control Software but that cannot be performed through Niagara Integrated Automation System

E. List all reports that can be generated in Native Lighting Control Software but that cannot be replicated in Niagara Integrated Automation System

F. Shop and Wiring Drawings: Submit shop drawings detailing control system, as supplied, including one-line diagrams, wire counts, coverage patterns, interconnection diagrams showing field-installed wiring and physical dimensions of each item.

G. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
   1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
   2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.

H. Software Operational Documentation:
   1. Software operating and upgrade manuals
   2. Program software backup on portable memory storage device
   3. Printout of software application and graphic screens, or upon request, a live demonstration of Control, Configure and Analyze functionality or a video demonstrating above stated system capabilities

I. Submit an Integration Plan. At a minimum include the following
   1. Network architecture and communications diagrams. Network architecture includes but is not limited to:
      a. Nodes
      b. Switches and Routers
      c. Integrated systems and/or sub-systems
      d. Dedicated I/O locations
   2. Coordination of vendor protocol and point list submission. Include an integration matrix detailing systems and all protocols applied.
   3. Workflow processes to integrate systems.
   4. Include communication hardware, software, and protocols to implement full systems integration.
5. Identify proposed enhancements or deviations from project documents. Include specific drawings or specifications impacted.

6. Identify coordination efforts to accommodate complete integration of systems including Vendor protocol requirements.

7. Provide a complete list in Excel spreadsheet format of all integrated points including:
   a. Device IDs
   b. Object ID
   c. Point ID
   d. Point Type
   e. Point Name
   f. Equipment
   g. Location
   h. Communication Protocol(s)

   J. Installation Instructions: Manufacturer’s installation instructions.

   K. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals

   L. Warranty: Copy of applicable warranty

   M. Additional information as required on a project specific basis

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

1.5 QUALITY ASSURANCE

   A. Installer Qualifications: Installer shall be CALCTP Certified and experienced in performing the work of this section, and who has specialized in installation of work similar to that required for this project.

   B. Manufacturer Requirements: If the system being proposed has been in production for fewer than 5 years, the manufacturer shall provide hardware for testing and demonstration. Manufacturer shall provide 24/7 telephone support by qualified technicians.
      1. Phone Support: Toll free technical support shall be available.
      2. Remote Support: The manufacturer shall offer remote support capability.
      3. Onsite Support: The manufacturer shall offer onsite support that is billable at a whole day rate.
      4. Service Contract: The manufacturer shall include a Service Contract that packages phone, remote, and onsite support calls for the project. Response times for each type of support call shall be as follows and indicated in the terms of the service contract included in the bid package.
         b. Onsite Support: Next business day.

Specifier to consult SU on response times expectations.

C. Contractor shall ensure that lighting system control devices and assemblies are fully compatible and can be integrated into a system that operates as described in the lighting control notes on drawings and as described within this specification. Any incompatibilities
between devices, assemblies, and controllers shall be resolved between the contractor and
the system provider, as required to ensure proper system operation and maintainability.

D. Performance Requirements: provide all system components that have been manufactured,
assembled, and installed to maintain performance criteria stated by manufacturer without
defects, damage, or failure.

E. Code Requirements
1. All system components shall be UL listed and certified.
2. All system components shall be FCC /IC compliant.
3. System electrical components shall be listed or recognized by a qualified testing
agency (UL, ETC) and shall be labeled with required markings as applicable.
4. All components and the manufacturing facility where the product was manufactured
must be RoHS compliant.
5. All system components shall be installed in compliance with National Electrical Codes.
6. Building Codes: All units shall be installed in compliance with applicable, local building
codes.

F. ISO Certification: System components shall be manufactured at ISO-9000 certified plants.

G. Coordination
1. Coordinate lighting control components to form an integrated interconnection of
compatible components.
   a. Match components and interconnections for optimum performance of lighting
      control functions.
   b. Display graphics, in Niagara Integrated Automation System, showing building
      areas controlled; include the status of lighting controls in each area.
   c. Coordinate Sequence of Operations, Controls Matrix, and Task Tuning Table with
      Stanford University Project Manager. Provide all required sequence of operations
      requirements on lighting plans. Lighting controls data used for HVAC sequences
      will be specified in Division 25xxxx.

1.6 PROJECT CONDITIONS

A. System devices shall meet the following environmental conditions:
1. Operating Temperature Range: 14 deg F (-10 deg C) to 90 deg F (+32 deg C).
2. Relative Humidity: 0% to 100% RH condensing rated for damp locations. Less than
90% non-condensing rated for indoor locations.

1.7 DELIVERY, STORAGE & HANDLING

A. Ordering: Comply with manufacturer’s ordering instructions and lead-time requirements to
avoid construction delays.

B. Delivery: Deliver materials in manufacturer’s original, unopened, undamaged packaging
with intact identification labels.

C. Storage and Protection: Store materials away from exposure to harmful weather
conditions and at temperature and humidity conditions recommended by manufacturer.

1.8 WARRANTY

A. Submit warranty documentation upon completion of project or phase and acceptance by
Engineer and Owner.
B. Warranty start date shall be the date of project written acceptance by Engineer and Owner.

1. Warranty Period: All system hardware components shall have full warranty (non-prorated) for a period of forty-eight (48) months

C. Repair or replace systems or parts found defective at no cost to Owner including: but not limited to:

1. Building Controls System Server software, project-specific software, graphic software, database software, and firmware updates that resolve known software deficiencies, as identified by the Contractor or Owner, shall be provided and installed at no charge during the warranty period.

2. Contractor to apply all software updates and security patches immediately (within 72 hours) as they become available, from the start of the project until the end of the warranty period.

3. All corrective software modifications made during the warranty period shall be updated on all user documentation and on user and manufacturer archived software disks.

4. Include parts, labor, and necessary travel during warranty.

5. All parts should be replaced with the exact products. If exact parts are not available then the equivalency determination rests with the Owner.

6. Troubleshooting service, preventative maintenance, and scheduled re-calibration of the system is the responsibility of the Owner. Such routine tasks shall not impact Contractor warranty obligations.

D. Owner will initiate service calls when the system is not functioning properly. Qualified personnel shall be available to provide service to the complete system. Furnish Owner with a telephone number where service representative can be reached at all times. Service personnel shall be at the site within 24 hours after receiving a request for service.

E. Provide vendor specific warranty information.

F. At the end of the warranty period, Contractor shall ensure every instance of manufacturer's software has the latest software maintenance release installed.

G. Expiration of the warranty period does not relieve Contractor of the responsibility for correcting all deficiencies identified during the warranty period. Expiration of the warranty period does not relieve Contractor of the responsibility for fulfilling all specified obligations during warranty period.

1.9 MAINTENANCE & SUSTAINABILITY

A. The manufacturer shall make available to the owner new parts, upgrades, and/or replacements for a minimum of 5 years following installation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS (ALPHABETICAL)

A. Controls:

1. DLM by Wattstopper, Inc.
2. Enlighted, Inc.
3. nLight by Acuity Brands, Inc.
4. Quantum by Lutron Electronics Co., Inc.

B. Sensors (confirm compatibility based on selected system manufacturer):

1. Cooper Controls, Inc.
2. Hubbell Building Automation, Inc.
4. PLC Multipoint Inc.
5. SensorSwitch by Acuity Brands Controls, Inc.
6. The Watt Stopper, Inc.

C. 0-10V Dimming/Fixed Output Ballasts/Drivers:
   1. EldoLED
   2. Osram
   3. Philips Lighting
   4. Tridonic
   5. Universal Lighting Technologies

2.2 SYSTEM REQUIREMENTS

This specification is intended to describe required components and technical services for a complete building-wide networked lighting control system. This system is specified to perform scheduled and automated lighting control sequences.

A. HARDWARE
   1. The lighting control system shall include an intelligently distributed digital network of devices that may not be integral to luminaires, sensors, switches, relays and other ancillary devices required for a complete and operable system.
   2. UL 924 and UL 916 listed devices shall have the ability to control 120V/277V load.
   3. System software interface shall have the ability to notify communication failures to system users.
   4. On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements may be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.

B. WALL STATIONS
   1. Description: The system shall connect with the wall stations. All wall stations shall at minimum meet the following general specifications.
   2. General
      a. Individual button for each zone
      b. Ability to adjust dimming level for each zone
   3. Multi-button scene controller: Conference Rooms, Lecture Halls, Auditorium, Theater, Multi-use Dining Hall/Multipurpose Rooms.
   4. Electrical:
      a. Class 2 Low Voltage device
   5. Mechanical:
      b. Color: Shall meet NEMA WD1 color specifications
      c. Mounts in standard size wall box (suitable for multi gang installation) or on mounting brackets for low voltage devices.
      d. Suitable for use with Decorator style wall plates.
   6. Reliability:
      a. Maximum Operating Ambient Temperature: 140 deg F (60 deg F).
      b. Humidity: 5% to 95% RH non-condensing rated for indoor locations.
   7. Regulatory:
a. Safety: UL916 listed
b. Environmental protection: Rated for dry location; RoHS compliant
c. Radio Interference: FCC Part 15/ICES-003
d. Shall comply or exceed the following electromagnetic requirements:
   1) EN 61000-4-2
   2) EN 61000-4-4
   3) EN 61000-4-5

C. NATIVE LIGHTING CONTROL SOFTWARE
1. Refer to Software Functional Matrix below to determine which software functions shall be performed with Native Lighting Control Software and which functions shall be performed with Niagara Integrated Automation System.
2. The Native Lighting Control Software shall offer central lighting control for the facility lighting administrator to perform, configuration and configuration maintenance
3. Native Lighting Control Software shall be utilized for complete programming without the need for third party hardware or software other than Niagara.
4. Native Lighting Control Software shall provide information on general system settings via mouse click.
5. Native Lighting Control Software:
   a. All scheduling shall be performed through Niagara Integrated Automation System
   b. Shall provide native, tile-based “thick” tools that can be launched from a central server. The program should be included with the system, non-labor intensive, nor be duplicative with Niagara graphics. Tiles shall show listed rooms and associated control components.
   c. All programming, assignments of lighting loads to control strategies, lighting status and lighting energy reporting shall be native to the software and executed from the included program. Editing shall be available without the need for any third party software, except Niagara. With the exception of Niagara, systems that utilize or require third party linked graphics are unacceptable, Niagara shall indicate the status of connected devices on the system and a warning indicator if a device goes offline.
   d. Software settings and properties shall be selectable per individual device, room based, floor based or global building based.
   e. Native Lighting control software interface shall provide current status and enable configuration of all system zones.
   f. Shall have the ability to display various lighting system parameters such as lighting status (ON/OFF), load shedding status, lighting energy consumption, and occupancy status.
   g. Energy Analysis data shall be exportable in CSV.
   h. Reports: Reporting feature shall be native to the lighting control software and capable of reporting the following parameters for each device and zone individually without requiring any third party hardware and software:
      1) Energy consumption broken down by energy management strategy
      2) Energy demand broken down by energy management strategy
   i. Building wide occupancy status
   j. Energy performance reports shall be printable in a printer friendly format and downloadable for use in spreadsheet applications, etc.

D. Daylight Harvesting: Photosensor shall trigger changes to light levels when ambient (natural) light is available and shall maintain a steady light level when subjected to fluctuating ambient conditions by dimming ballasts and/or drivers. Areas equipped with
fixed output ballasts and/or drivers shall energize when natural light falls below foot-candle levels specified. System shall utilize light level inputs from common and/or remote sensor locations to minimize the number of photosensors required. The system shall operate with multiple users in harmony and not react adversely to manual override inputs.

E. Time Clock Scheduling: The system shall be programmable for scheduling lights on or off via the Niagara Integrated Automation System.
   2. Override: Manual adjustments via wall stations or Niagara Integrated Automation system shall temporarily override off status imposed by time clock schedule.
   3. Flicker Warning: Prior to a scheduled lights-off event or expiry of a temporary override, the system shall provide short light level drops or flashes as a warning to the affected occupants. Warning time shall have the ability to be programmed via software between 1 and 5 minutes.

F. Load Shed Mode/Demand Response: Load shedding mode shall reduce output to a minimum of 15% of electrical demand load (configurable). The system shall not shed more load than required, and shall be centrally configurable by control zone or by common uses until the required defined load has been shed, for either a defined period, or until the demand response input has been removed.

G. Emergency Mode: There shall be a mode, when initiated through the Niagara Integrated Automation system, that will immediately adjust lights to full light output and retain that level until the mode is deactivated in the event of an emergency. This setting shall override all other inputs. The system shall interface with the building emergency monitoring system via a single convenient point and not require multiple connections.

H. Addressing: 0-10V is primary signal. Use of multiple Analog Outputs may be required to handle multiple dimming levels within the same room. A room controller may be required for large spaces with either a high number of Analog Outputs or sub-modules.

OR

[All ballasts and/or drivers shall be centrally addressable, on a per luminaire or multiple luminaire/zone basis, through the control software. To simplify ongoing maintenance, the system shall not require manual recording of addresses for the purpose of start-up or reconfiguration.]

I. Programmable Task Tuning: Maximum light level programmability shall be available.

J. Unoccupied State: The system shall provide two states when occupancy status is vacant as per an occupancy sensor - lights turn off or lights adjust to configurable (dimmed) light level.

K. Occupied State: The system shall be capable of creating “comfort” or “support” zones to ensure that occupants are not isolated by turning off lights in adjacent areas, such as a hallway path to exit the premises for occupant comfort and safety.

L. Participation in Intelligent Building Framework: The system shall have the ability to be a component of Intelligent Building framework.

M. LAN Operations: System shall be capable of operating independent of building’s existing network infrastructure if desired and shall not rely on tenant supplied PCs for operation.

N. Firewall Security: Firewall technology shall be utilized to separate tenants from the lighting control network.
O. Lamp Burn In: The system software shall have the capability of not permitting dimming of new lamps prior to completion of lamp manufacturer recommended accumulated operation at full brightness.

P. Re-configurability: The assignment of individual luminaire to zones shall be centrally configurable by control software such that physical rewiring will not be necessary when workspace reconfiguration or re-zoning is performed. Removal of covers, faceplates, ceiling tiles, etc. shall not be required.

Q. Sensor Control Parameters: Occupancy sensor time delays and light level sensor parameters shall be configurable through software.

R. Automatic Time Adjustment: System shall automatically adjust for leap year and daylight savings time and shall provide weekly routine and annual holiday scheduling.

S. The system software shall have the capability of providing an optional web based energy dashboard to show real time energy savings data.

T. The system shall have the ability to control (dim/switch) a group of luminaires with loads up to 20A.

U. System shall be capable of including scheduling of exterior luminaires via timeclock, if required.

V. System Integration Capabilities:
   1. The system shall interface with the Niagara Integrated Automation System to support two-way communication using the BACnet/IP protocol.
   2. The system shall support activation of system profiles from Demand Response Automation Servers via the OpenADR 2.0a protocol.

W. The light management system shall be capable of interfacing with audio-visual system (e.g. LCD Touch Screen Panel) via RS232 interface. Through this, interface users can command various lighting scenarios depending on the audio & visual requirements of the room or building.

X. Step Dimming & A/B Ballast Switching: System shall have the ability to perform Step Dimming & A/B Ballast Switching.

2.3 LIGHTING CONTROL STRATEGIES

A. Control Software: Control software application is used to start-up, configure and manage the system. Every system parameter in a building (or campus of buildings) is configured for each individual user or space and baseline settings are established for each of the following (depending on the basis of design) system features:
   1. Daylight harvesting
   2. Occupancy control
   3. Smart time scheduling
   4. Task tuning
   5. Personal control
   6. Load shedding
   7. Plug load control
2.4 AUDIO-VISUAL INTERFACE

A. General: Through the interface users can command (e.g. LCD Touch Screen Panel) various lighting scenarios depending on the audio & visual requirements of the room or building.

1. The lighting control system shall be capable of interface to the AV system via TCP/IP protocol using Telnet.
2. The lighting control system shall allow a common AV processor to individually control multiple rooms from a single TCP/IP port through unique room, zone, and scene addresses for lighting in each room.

2.5 NIAGARA INTEGRATED AUTOMATION SYSTEM INTERFACE

A. General:

1. All user functions shall be performed from the Niagara Integrated Automation System, without logging into Native Lighting Control Software.
2. Refer to Software Functional Matrix below to determine which software functions shall be performed utilizing Native Lighting Control Software and which functions shall be performed using Niagara Integrated Automation System.
3. System architecture shall prioritize BACnet MS/TP or vendor proprietary serial communications over BACnet/IP communications when possible to limit the number of BACnet/IP based devices in the system.
4. Ensure that all BACnet/IP routers serving BACnet MS/TP or vendor proprietary communication trunks have sufficient processor power and memory capacity to route all BACnet traffic without delays or overloading. Limit the number of devices per trunk if required to ensure traffic is routed correctly.
5. Provide point list matrix of available points for integration that includes: Point name, device ID, object ID, point type and point type number.
6. Devices shall support both COV subscription based binding and polling interval binding.
7. Include latest version of protocol profiles used. Provide a BACnet Protocol Implementation Conformance Statement (PICS) for each type of controller and operator interface. Include complete set of BACnet Implementation Building Blocks.
8. Coordinate polling rate requirements to minimize network traffic.
10. Provide BACnet/IP WireShark or equivalent protocol analyzer traffic capture report of at least 5 minutes of network traffic.

B. Software Functional Matrix

<table>
<thead>
<tr>
<th>Native Lighting Control Software</th>
<th>Niagara Integrated Automation System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start-up, program and configure the lighting system</td>
<td></td>
</tr>
<tr>
<td>Assignments of lighting loads to control strategies</td>
<td></td>
</tr>
<tr>
<td>Configuration of all lighting system zones</td>
<td></td>
</tr>
<tr>
<td>Configuration maintenance</td>
<td></td>
</tr>
<tr>
<td>Remote configuration</td>
<td>All End-User functions</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>View lighting floorplans</td>
<td></td>
</tr>
<tr>
<td>All reporting</td>
<td></td>
</tr>
<tr>
<td>All Monitoring</td>
<td></td>
</tr>
<tr>
<td>Import Niagara Schedules</td>
<td>All scheduling shall be initiated, controlled and managed from Niagara Integrated Automation System</td>
</tr>
<tr>
<td></td>
<td>All trending shall be configured, initiated, controlled, archived and managed from Niagara Integrated Automation System.</td>
</tr>
<tr>
<td>Not Acceptable to generate Alarms in Native Lighting Control Software and pass to Niagara except Low Battery Alarm and Offline Controller Alarm</td>
<td>All alarming shall be configured, initiated, controlled, archived and managed from Niagara Integrated Automation System, Except Low Battery Alarm and Offline Controller Alarm may be configured in Native Lighting Control Software only if not possible in Niagara.</td>
</tr>
<tr>
<td>Read and Acknowledge: Low/Failed Battery Alarm</td>
<td></td>
</tr>
<tr>
<td>Read and Acknowledge: Offline Controller Alarm</td>
<td></td>
</tr>
<tr>
<td>Read and Write: Light Zone State: State of the defined lighting zone – ON or OFF</td>
<td></td>
</tr>
<tr>
<td>Read and Write: Light output level of the defined lighting zone, from 100% (maximum light output) to 0% (minimum light output)</td>
<td></td>
</tr>
<tr>
<td>Read and Write: Light output level of the defined lighting zone, In Foot-candles, maximum light output to minimum light output.</td>
<td></td>
</tr>
<tr>
<td>Read: Occupancy State. State of the defined occupancy sensor – occupancy detected or not detected</td>
<td></td>
</tr>
<tr>
<td>Read: Photo Sensor Daylight Readings: Reports daylight readings by photo sensors</td>
<td></td>
</tr>
<tr>
<td>Read and Write Shed Status: Reports the total current load reduction achieved according to the system-defined prioritization, defined in watts</td>
<td></td>
</tr>
<tr>
<td>Read: Lighting Energy Consumption by Zone</td>
<td></td>
</tr>
</tbody>
</table>

C. BACnet Building Controller (B-BC):
1. BACnet Building Controllers (B-BCs) shall provide direct connection to the secondary port of the local JACE controller and serve as communications router for other controllers on slower speed BACnet MS/TP networks or vendor proprietary. 
2. B-BCs shall be BACnet Testing Lab listed.
3. B-BCs BACnet points shall support COV and subscription based polling.
4. Communication between B-BC’s shall be through BACnet/IP communication.
5. B-BC’s shall have sufficient processor capabilities, storage and RAM to implement all types of custom software applications and shall provide supervisory control, scheduling, trend logging & alarm handling functions as follows:
   a. Scheduling:
      1) All scheduling shall be initiated, controlled and managed from Niagara Integrated Automation System.
      2) Each B-BC shall support a minimum of 250 BACnet Schedule Objects and 250 BACnet Calendar Objects.
   b. Trending:
      1) All trending shall be configured, initiated, controlled, archived and managed from Niagara Integrated Automation System.
      2) Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable from Niagara Workbench.
   c. Alarm Generation:
      1) All alarming shall be configured, initiated, controlled, archived and managed from Niagara Integrated Automation System.

6. B-BC's shall have uninterrupted real time clocks capable of time of day, week, and year information to the system as needed to perform software functions. Clock shall be programmed to reset twice per year to allow for Daylight Savings Time. Clocks in multiple DDC Controllers shall be automatically synchronized to Stanford NTP Time Server: time.stanford.edu, Accuracy shall be within 1 second per day.
7. Batteries shall maintain volatile memory and real time clocks for a period of at least 72 hours during power failure. Batteries shall be maintenance free and have minimum life of 2 years. System shall alarm upon low/failed battery condition. When power has been restored, the following shall occur automatically:
   a. Orderly startup of controlled equipment (user defined)
   b. Continuation of control algorithms
   c. Database revision
   d. Logging of power interruption and restoration times
   e. Battery recharging
8. Each B-BC shall include its own micro-processor, power supply, input/output modules, and termination modules as required to perform intended function.
9. BACnet UDP port number to always be set to 47808 (BAC0 in hexadecimal).

D. Zone/Room Level Communications (if BACnet MS/TP)
1. Provide equipment with BACnet MS/TP communications that is BACnet Testing Lab listed.
2. Provide point list matrix of available points for integration that includes: Point name, device ID, object ID, point type and point type number.
3. Devices shall support both COV subscription based binding and polling interval binding.
4. Include latest version of protocol profiles used. Provide a BACnet Protocol Implementation Conformance Statement (PICS) for each type of controller and operator interface. Include complete set of BACnet Implementation Building Blocks.

5. Coordinate polling rate requirements to minimize network traffic.

6. Provide support and coordination for integration with Niagara Integrated Automation System specified in division 25. Assist in system setup (addressing, naming, etc).

7. Configure MS/TP trunk baud rates minimum speed ensure required refresh times, cov updates or polling rates are successful. Preferred minimum baud rate is 38.4 kbps.

8. Limit the number of devices on a MS/TP trunk to no more than 64.

9. Configure Max Masters for the highest address on the trunk.

10. Provide MS/TP traffic capture report of at least 5 minutes of network traffic.

E. General: The Native Lighting Control Software shall communicate the status of output devices (lighting loads) as well as input devices (dry contacts, switches, occupancy sensors, vacancy sensors, and photocells) over to the Niagara integrated automation system. Niagara Integrated Automation System shall be able to utilize data from lighting control system to switch/dim lighting, perform load shedding of lighting load, to turn lights on in response to emergency signal through fire alarm and perform HVAC adjustments.

1. The Native Lighting Control Software shall share the following information with the Niagara Integrated Automation System:
   a. Light Zone State: State of the defined lighting zone – ON or OFF
   b. Light Zone Dimming: Light output level of the defined lighting zone, from 100% (maximum light output) to 0% (minimum light output)
   c. Occupancy State: State of the defined occupancy sensor – occupancy detected or not detected
   d. Photo Sensor Daylight Readings: Reports daylight readings by photo sensors
   e. Shed Status: Reports the total current load reduction achieved according to the system-defined prioritization, defined in watts

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Verification: Verify that wiring conditions, which have been previously installed under other sections or at a previous time, are acceptable for product installation in accordance with manufacturer’s instructions.

B. Inspection: Inspect all material included in this contract prior to installation. Manufacturer shall be notified of unacceptable material prior to installation.

3.2 INSTALLATION

A. The Electrical Contractor, as part of the work of this section, shall coordinate, receive, mount, connect, and place into operation all equipment. The Electrical Contractor shall furnish all conduit, wire, connectors, hardware, and other incidental items necessary for properly functioning lighting control as described herein and shown on the plans (including but not limited to control devices, 0-10V dimming ballasts, fixed output ballasts, 0-10V LED drivers and communication wire), as well as interconnect wiring between lighting and JACES. The Electrical Contractor shall maintain performance criteria stated by manufacturer without defects, damage, or failure.

B. Power: The contractor shall test that all branch load circuits are operational before connecting loads to sensor system load terminals, and then de-energize all circuits before installation.
C. Related Product Installation: Refer to other sections listed in Related Sections for related products’ installation.

3.3 SENSOR INSTALLATION

A. Adjust sensitivity to cover area installed

B. Set time delay on occupancy sensors that are connected to the lighting control system as detailed in the Sequence of Operations below. Time delays shall be controlled via control software.

C. Install interior light sensor in ceiling facing the floor.

3.4 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 3/4 inch.

B. Wiring within Enclosures: Comply with NEC & CEC. Separate power-limited and non power-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 SOFTWARE INSTALLATION

A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current site licenses for software.

3.6 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following field tests and inspections with the assistance of a factory-authorized service representative:
   1. Operational Test: After installing wall stations and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Lighting control devices will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 SYSTEM START-UP REQUIREMENTS & SUPPORT SERVICES

A. System Start-up: The manufacturer shall supply factory trained representatives to start-up the lighting control system.

B. Integration Support:
   a. The manufacturer shall supply factory trained representatives to assist with integration to the BMS system.
   b. PLUG FEST
i. In cooperation with Div. 25, Integrated Automation contractor, fully participate in plug fest of integrated systems as shown on Network Architecture diagram.

ii. Verify communication capabilities of each lighting device prior to installation of each system. Only one device, typical of identical devices, is required to be tested.

iii. Provide and coordinate testing methodology with Div. 25 contractor.

iv. Test architecture will mimic monitored building systems. Testing methodology will also include read/write capabilities as required.

v. Verify through auto-discovery of BACnet network or registry list of Modbus network – availability of all required point lists.

vi. Goal of the plugfest is to find and resolve any integration, latency and/or interoperability type issues.

vii. Provide adequate power, high speed local area network for system connections.

viii. SU representative will monitor all IT network activities.

C. Training: As part of the system start-up service, the provider of the service shall train the facility staff, or end users, responsible for changing the lighting characteristics in a building in the operation of the system. The start-up service provider shall also provide owner’s representatives with system operating manuals.

D. Provide a minimum of sixteen (16) hours of training, organized into four (4) separate sessions of four (4) hours each session. Refer to 250000 1.12 “Owner’s Training” for full training requirements.

E. Extended Service Coverage: Maintenance agreements shall be available from the manufacturer to provide service for the system both during and after the warranty period.

F. Requests for start-up or technical services shall be at least fifteen (15) business days prior to date desired for service.

G. Electrical contractor shall perform functional testing under the guidance of technical service agent and in accordance with factory specified guidelines.

H. Technical service provider shall provide technical services for the lighting control system.
   1. Verify proper communication between all devices.
   2. Verify communication to control software.
   3. Software configuration of occupancy sensors, light level sensors, wall stations and other contacts to suit design specifications.
   4. Configure and program lighting control sequences as described in Sequence of Operations below.
   5. Demonstrate to Owner and Engineer proper operation of all areas the system is installed.
3.8 TESTING

A. Upon completion of all line, load and interconnection wiring, and after all luminaire are installed and lamped, a qualified factory representative shall completely configure and test the system.

B. At the time of checkout and testing, the owner’s representative shall be thoroughly instructed in the proper operation of the system.

3.9 DEMONSTRATION

A. The provider of the service shall train the facility staff, or end users, responsible for changing the lighting characteristics in a building to adjust, operate, utilize, troubleshoot, conduct software installation, and maintain lighting controls and software training.

**PART 4 - SEQUENCE OF OPERATIONS (BASED ON INDIVIDUAL PROJECTS)**

<table>
<thead>
<tr>
<th>AREA</th>
<th>SCHEDULING</th>
<th>MANUAL OR AUTO-ON OCCUPANCY SENSOR</th>
<th>AUTO-OFF OCCUPANCY SENSOR SETTING</th>
<th>TASK TUNING</th>
<th>DAYLIGHT ZONES</th>
<th>EGRESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conf/Team Rooms</td>
<td>Through Niagara Integrated Automation System</td>
<td>MANUAL</td>
<td>5 MINS</td>
<td>Refer to 265100</td>
<td>30fc</td>
<td>AUTO SWITCH UPON LOSS OF NORMAL POWER</td>
</tr>
<tr>
<td>Breakrooms</td>
<td>Through Niagara Integrated Automation System</td>
<td>AUTO</td>
<td>15 MINS</td>
<td>Refer to 265100</td>
<td>20fc</td>
<td>AUTO SWITCH UPON LOSS OF NORMAL POWER</td>
</tr>
<tr>
<td>Laboratories and Lab Support</td>
<td>Through Niagara Integrated Automation System</td>
<td>AUTO</td>
<td>15 MINS</td>
<td>Refer to 265100</td>
<td></td>
<td>AUTO SWITCH UPON LOSS OF NORMAL POWER</td>
</tr>
<tr>
<td>Open Office</td>
<td>Through Niagara Integrated Automation System</td>
<td>AUTO</td>
<td>15 MINS</td>
<td>Refer to 265100</td>
<td>30fc</td>
<td>AUTO SWITCH UPON LOSS OF NORMAL POWER</td>
</tr>
<tr>
<td>Copy Rooms</td>
<td>Through Niagara Integrated Automation System</td>
<td>MANUAL</td>
<td>5 MINS</td>
<td>Refer to 265100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical/ IDF/ UPS/ Mech</td>
<td>Through Niagara Integrated Automation System</td>
<td>AUTO</td>
<td>5 MINS</td>
<td>Refer to 265100</td>
<td>AUTO SWITCH UPON LOSS OF NORMAL POWER</td>
<td></td>
</tr>
<tr>
<td>----------------------------</td>
<td>------------------------------------------------</td>
<td>------</td>
<td>--------</td>
<td>-----------------</td>
<td>-------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Laboratory Corridors</td>
<td>Through Niagara Integrated Automation System 30% output between 7am and 7pm when occupancy is not detected</td>
<td>AUTO</td>
<td>15 MINS</td>
<td>Refer to 265100</td>
<td>AUTO SWITCH UPON LOSS OF NORMAL POWER</td>
<td></td>
</tr>
<tr>
<td>Office corridors and Stairwells</td>
<td>Through Niagara Integrated Automation System 10% output between 7am and 7pm when occupancy is not detected</td>
<td>AUTO</td>
<td>5 MINS</td>
<td>Refer to 265100</td>
<td>15fc AUTO SWITCH UPON LOSS OF NORMAL POWER</td>
<td></td>
</tr>
<tr>
<td>Restrooms</td>
<td>Through Niagara Integrated Automation System 10% output between 7am and 7pm when occupancy is not detected</td>
<td>MANUAL</td>
<td>15 MINS</td>
<td>Refer to 265100</td>
<td>AUTO SWITCH UPON LOSS OF NORMAL POWER</td>
<td></td>
</tr>
</tbody>
</table>

a. END OF SECTION