

SECTION 26 09 50 – LIGHTING SEQUENCE OF OPERATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes control sequences for building lighting systems and equipment. Sequence of operation is hereby defined as the manner and method by which various controls and systems function. Initial requirements for the operation of each type of space are specified in this section and/or on the contract drawings. Provide all necessary materials and labor to supply a complete and fully operational system.
 - B. The system shall include a completely distributed control system with no required front-end computer. Programming shall be handled via the Wi-Fi network using a hand-held device should a front-end computer be provided or not. Refer to Division 26 "Distributed Lighting Management System" for additional information.
 - C. Provide connections to other systems as listed in part 3.
 - D. Light fixtures shall be supplied with 0-10V dimming drivers, and the lighting control system shall integrate with these drivers.
 - E. While an initial sequence is provided as part of these shop drawings, the vendor **MUST** schedule a meeting with the owner to verify all sequences meet the owner's needs, and also meet currently adopted International Energy Conservation Code requirements. **It is the Vendor's responsibility to schedule this meeting, through the prime contractor, prior to any programming, and to avoid any delays in the project.** A lack of coordination with the owner **WILL** necessitate additional programming, that will be required to be performed within 24 hours of notice of any issue.
 - 1. The Vendor shall document all attendees of the meeting, including email addresses.
 - 2. The Vendor shall take meeting minutes of all discussions, and write a modified sequence as needed.
 - 3. The Vendor shall distribute the meeting minutes and modified sequence to all Attendees, Owner's rep, Architect and Engineer within 5 business days after the meeting for review and comment. The meeting shall take place prior to any initial programming of the system; however, should the meeting take place
 - F. This project is a phased project, with may sub-phases. In order to ensure that the building is usable as the project progresses, the following expectations **MUST** be met:
 - 1. No occupancy sensor shall function until the system is fully operations. Under no circumstances shall the lights in the educational spaces automatically turn on to 50%.
 - 2. It shall be acceptable, and expected to allow educational spaces, offices and conferences rooms to operation **ONLY** through wall controls until the final completion of the project.
 - 3. Care must be taken to ensure easy usability of the lighting controls within educational spaces during the construction of the project.
- 1.2 SHOP DRAWINGS: Submit shop drawings in coordination with the "Distributed Lighting Control System" shop drawings:
- A. Provide a description of how the building will be initially programmed as a whole, including the control of and afforded to any and all interconnecting systems.

LIGHTING SEQUENCE OF OPERATIONS

- B. Provide a description of how each space will be initially programmed including the hierarchy of control sequences, whether the space is listed within this specification or not.
- C. Provide a full single-line diagram showing all control devices and the connection points. Diagrammatically show the associations of these control devices with the applicable spaces. The single-line shall also show connections to other systems, indicating method and communications protocol.
- D. Provide layout drawings indicating the proper location of daylight sensors.
- E. Coordinate the connection of occupancy sensors with the occupancy sensor supplier. Show these connections in detail.
- F. Coordinate the connection of other lighting control systems and control devices, including, but not limited to remote architectural control systems, remote theatrical control systems and touchscreens. Review drawings and specifications for additional information.
- G. Maintenance Data: Include copy of shop drawings in each maintenance manual; in accordance with requirements of Division 1.
- H. When preparing submittals and programming, use a room number schedule generated by the architect and/or the owner, which indicates the actual room numbers that will be used when the building is occupied. If the schedule is not available, revise the initial submittal, when a schedule is available, to reflect the proper room numbers.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 LIGHTING MANAGEMENT SYSTEM (LMS)

- A. The LMS shall include all hardware, software and programming required to fully execute all control sequences and monitor all control points described in this specification. The LMS shall have the capabilities to perform the control strategies, energy management functions, and lighting management functions listed. LMS software to perform override commands and backup of remote-control unit(s) shall reside on a rack mounted server to be located in the Main Data Room, or as indicated elsewhere in the specifications or on the drawings.
- B. Set Point Control: The LMS software shall have full editing capabilities of the control sequences for all set point control logic residing in remote control units and the lighting management software. In the Event of a communication loss between the LMS server and any remote-control unit(s), all local control sequences must remain active, including, but not limited to local occupant control, occupancy sensing and daylight harvesting. Once connection is reestablished, normal operation shall be reenacted.
- C. Operating Mode Control: The LMS shall have full 24 hr./ 365-day scheduling capabilities for occupied/unoccupied modes of operation for all systems regardless of whether sequencing logic resides in a remote-control unit or the lighting management software. The control system shall be capable of fully executing all schedule sequences listed to be stored within the remote-control unit(s) in the event of a communication loss between the LMS server and any remote-control unit(s).

LIGHTING SEQUENCE OF OPERATIONS

- D. Alarm Management: The LMS shall monitor, buffer, and direct alarm reports to operator devices and memory files. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three (3) priority levels shall be provided.
 - 1. The conditions under which alarms need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date shall be definable by the user.
 - 2. Report Routing: Alarm, reports, messages, and files will be directed to a user-defined list of operator devices for archiving alarm information. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.
 - 3. Alarm Messages: In addition to the point's descriptor and the time and date, the user shall be able to display or store a 65-character alarm message to more fully describe the alarm condition or direct operator response.
 - 4. Auto-Dial Alarm: The user shall define which critical alarms shall initiate a call to a remote operator device.
- E. Historical Data and Trend Analysis: The LMS software shall be capable of automatically sampling, storing, and displaying system data in all of the following ways:
 - 1. Continuous Point Histories: A point history routine shall continuously and automatically sample the value of all analog and binary inputs and outputs at fifteen-minute intervals. Samples shall be stored for the past 72 hours to allow the user to immediately analyze equipment performance and all problem-related events. History files shall include a continuous record of the last ten status changes or commands for each point.
 - 2. Data Storage and Archiving: Trend data shall be uploaded from local unit controllers to the LMS software at pre-determined intervals or when the trend buffers become full.
- F. Totalization: The LMS software shall be capable automatically accumulating, storing, and displaying totals as follow:
 - 1. Runtime: Automatically accumulate, store, and display runtime hours for binary input and output points as specified in sequence of operations specifications. The totalization routine shall have a sampling resolution of 1-minute or less. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.
 - 2. Event: Automatically count, store, and display event occurrences (such as the number of times the lights in a space is turned on and off) on a daily basis for user selected events.

3.2 GENERAL LIGHTING CONTROL SEQUENCES

- A. Scheduled Control
 - 1. Each remote lighting hub shall be capable of being provided with a predetermined scheduled control via the following methods:
 - a. Scheduled time of day through the use of a timeclock or front-end computer.
 - b. Indication from any connected system (i.e. BMS).
 - c. Indication from a contact closure connected to a system or device (i.e. photoelectric cell).
 - 2. Should a front-end file server/computer be added in the future, scheduled control shall be capable of being set independently for each space and/or relay based on the above control methods.
- B. Occupancy Sensors
 - 1. The occupancy sensors in each space shall be programmed to control, at a minimum, the lighting within that space.

LIGHTING SEQUENCE OF OPERATIONS

2. Occupancy sensors that are connected with the system shall be capable of controlling any lighting fixture and/or relay connected within the system through programming.
3. The front-end computer shall be capable of sending an alarm signal when an occupancy sensor connected into the system detects a person during "Unoccupied" mode. The alarm signal shall be sent to a connected security system, building management system and/or as an alarm input as part of the front-end computer.

C. Occupant Control

1. In addition to the use of occupancy sensors, each indicated space shall have local occupant controls.
2. Unless otherwise stated, local occupant controls shall be used to activate the local lighting, and connected occupancy sensors to maintain lighting, and provide automatic off (i.e., vacancy sensor setting).
3. The local occupant controls shall be capable of turning the local lighting off.
4. The local occupant controls shall be capable of dimming the local lighting.
5. Through programming, the local occupant controls shall be capable of being a local override to the scheduled control. Override shall last a maximum of 2 hours without additional intervention.
 - a. If the scheduled control is via connection with another system, the front-end computer shall send a signal indicating that the building is occupied. If the connection is via digital link (Bacnet or ModBus), the signal shall also indicate the space sending the override signal.

D. Daylight Harvesting

1. Each space indicated with a daylight sensor shall be programmed with daylight harvesting.
2. Each row parallel with the window wall shall be set with individual gains according to the amount of daylight that enters the room proportional to each other row.
3. Where an average amount of light is not indicated elsewhere for each space, it shall be assumed that an average of 40 foot-candles for direct lighting and 35 foot-candles for indirect lighting shall be maintained.
4. Lighting shall reach a minimum level of lighting without turning off. Any changes to the lighting shall happen at such a rate that the occupants are not aware of any dimming of the light fixtures.

E. General Order of Operations

1. Each space/relay shall follow the following order of operations, where applicable, unless noted otherwise in the specifications or drawings:
 - a. On-Off Control:
 - 1) Local Occupant Control.
 - 2) Local Occupancy Sensors.
 - 3) Override control of connected systems.
 - 4) Time-of-day schedule.
 - b. In spaces with dimming control, the lowest value shall always take precedence.

F. Normal/Emergency lighting:

1. In spaces where normal/emergency lighting is indicated along with normal lighting that is controlled via the system, the normal/emergency lighting shall function with the normal lighting so that the occupancy has no idea that there are two (2) different lighting circuits in the space.
2. If the building loses power, the control for the lighting shall fail, and the normal/emergency lighting shall operate at 100% light output from the emergency generator.

LIGHTING SEQUENCE OF OPERATIONS

3. In spaces where normal/emergency lighting is indicated, but the normal lighting is controlled outside of the system (i.e., occupancy sensor with power pack, or just a wall switch), the normal/emergency lighting shall operate at 100% 24 hours per day.
4. Unless noted otherwise, in spaces where normal/emergency lighting is indicated, and controlled outside of the system (i.e., switch type occupancy sensor in private restroom), the normal/emergency lighting shall operate via control device only, with no UL listed relay. These spaces have been designed with emergency lighting for convenience.

3.3 INITIAL SPACE SPECIFIC CONTROL SEQUENCES

A. Exterior Lighting:

1. BMS Controlled. Provide Lutron relay panels (RP#) where identified on the drawings for exterior lighting. Provide 20 amp, 1-pole relays in quantity indicated on drawings. Provide interface with the BMS to allow control of the exterior lighting relays.

B. Corridor Lighting:

1. "Unoccupied" and "Occupied" modes shall be controlled via timeclock function. Wall switches shall be provided, as indicated on the drawings, for 2-hour override control.
2. During "Unoccupied" mode, all of the light fixtures in the corridor shall be set to a minimum level as directed by the owner. Initially, the lighting shall be programmed to be set to 30% lighting output during "Unoccupied" mode. Should the owner choose, the lights may be set to turn off. The occupancy sensors shall allow the corridor lights to ramp to "Occupied" level output upon occupant detection.
3. During "Occupied" mode, all of the light fixtures in the corridor shall be set to a fixed level with no occupancy sensor control. Sufficient light to provide an average light level of 30 foot-candles as measured throughout the corridor with a calibrated light meter at the floor shall initially be used, unless directed otherwise by the owner. Where daylight sensors are indicated in the corridor, the light fixtures within the daylight zone as identified by the currently adopted version of the International Energy Conservation Code (IECC) shall be programmed to be controlled via the daylight sensor.
4. During "Unoccupied" mode, when the occupancy sensors do not detect a person for a period of 5 minutes, the lights shall reduce back to the low level.
5. The display cases shall function on the unoccupied/occupied signal. They shall be "off" during unoccupied and "on" during occupied. An additional low voltage dimmer shall be installed at each display case to allow control of the light output.
6. "Occupied" and "Unoccupied" schedule shall be set via time as follows:
 - a. "Occupied" mode shall be Monday - Friday from 7:00am - 3:00pm.
 - b. "Unoccupied" mode shall be Monday - Friday from 3:00pm - 7:00am and all-day Saturday and Sunday.
 - c. The schedule shall be verified with the owner prior to programming, and adjusted accordingly.

C. Stairwell Lighting:

1. Control shall be based on Corridor "Unoccupied" and "Occupied" modes.
2. Where fixtures in the stairwell have uplight and downlight components, these components shall be controlled independently. During the initial programming, a question shall be asked of the design team regarding the uplight component of the stairwell to ensure the visual impact of the building is realized.

LIGHTING SEQUENCE OF OPERATIONS

3. During "Unoccupied" mode, all of the light fixtures in the stairwell shall be set to a minimum level as directed by the owner. Initially, the lighting shall be programmed to be set to 50% lighting output during "Unoccupied" mode.
 4. During "Occupied" mode, all of the light fixtures in the stairwell shall be set to light level as set by the owner. Sufficient light to provide an average light level of 30 foot-candles as measured throughout the stairwell with a calibrated light meter at the floor shall initially be used, unless directed otherwise by the owner. Where daylight sensors are indicated in the stairwell, all of the light fixtures within the daylight zone as identified by the currently adopted version of the International Energy Conservation Code (IECC) shall be programmed to be controlled via the daylight sensor.
- D. Instructional Space (including classrooms, cafeteria, gymnasiums, etc.), Office and Conference Lighting:
1. Occupancy sensors connected with the lighting system shall be set as vacancy sensors, so that to turn the lights on, a person has to manually activate the wall control. When a person uses the local occupant control, the lights shall turn on to the level indicated. As long as the occupancy sensor detects a person, the lights shall remain on. The lights shall turn off when the occupant turns off the lights via the local occupant control. If the occupancy sensor stops detecting a person for 10 minutes, the lights shall turn off.
 2. Where there is under cabinet lighting, they shall be controlled by the indicated control station, only in an on/off manner (i.e., if the station is on, the undercabinet lighting is on; however, when the station indicates dimming, the undercabinet lighting does not dim.). Undercabinet lighting shall be supplied with its own line voltage switch so that it can be switched off independent of the room lights (although the undercabinet lighting cannot be turned on without the room lights being on).
 3. **In addition to the lighting controls, these spaces shall have an additional connection to the local HVAC terminal unit (fan powered VAV, VAV, blower coil, fan coil unit, etc.) to provide occupancy status. The Occupancy sensors are specified with a relay to allow this connection; however, should the controls manufacturer elect to use a system connected relay, that shall be an acceptable alternative.**
- E. Multi-gang Restroom Lighting:
1. All of the light fixtures shall be at 10%. When a person is detected by the occupancy sensor, the lights shall rise to a predetermined light output as directed by the owner. The lighting shall initially be set to 90% output, unless directed otherwise by the owner.
 2. When the occupancy sensors do not detect a person for a period of 5 minutes, the lights shall reduce to 10%.
- F. Storage Lighting:
1. When a person is detected by the occupancy sensor, the lights shall turn on, unless the local line voltage switch is in the off position.
 2. When the occupancy sensors do not detect a person for a period of 5 minutes, the lights shall turn off.
 3. General storage room lighting is not controlled via the distributed digital lighting control system and uses line voltage controls.
- G. Theatrical Lighting Control System:
1. The theatrical lighting control system shall function on its own.

3.4 CONNECTION TO OTHER SYSTEMS

- A. UL924 listed voltage sensing units shall be provided at each remote power supply and be connected to the lighting panel associated with the lighting in the area. Connect to the breaker indicated in the lighting panelboards.
- B. Provide a connection with the fire alarm system via contact closure. When the fire alarm system goes into alarm, all of the connected lighting shall go to full output. When the fire alarm system is reset, the lights shall go to their preset level. This connection shall be 1-way.
- C. Provide a connection with the mechanical building automation system via Bacnet over IP to control the exterior lighting. Coordinate with the mechanical building management system provider and provide all required programming for facilitate all previously stated information to be passed between the mechanical building automation system and the relay panels.
 - 1. The gateway shall interface all exterior lighting relays, including building mounted, landscape and area lighting.

END OF SECTION 26 09 50