SECTION 16930

LOW VOLTAGE REMOTE CONTROL RELAY SYSTEM (LIGHTING CONTROLS)

PART 1 - GENERAL

1.01 SCOPE

A. Work Included: All labor, materials, appliances tools, equipment, facilities transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete as shown on the drawings and/or specified herein. Work includes, but is not necessarily limited to the following:
   1. Examine all other sections for work related to those other sections and required to be included as work under this section.
   2. General provisions and requirements for electrical work.

B. Related Sections:
   1. Section 16050 – Wiring Devices/Lighting Controls
   2. Section 16500 – Ballasts: Fluorescent lighting ballasts controlled by central dimming control system.

1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. General
   1. Submit product data sheets with performance specifications demonstrating compliance with specified requirements for all switches, relays, wiring devices, device plates, controllers, power supplies, cabinets, etc.
   2. Submit detailed shop drawings including dimensioned plans, elevations, details, schematic and "point-to-point" wiring diagrams and descriptive literature for all component parts and cabinets.
   3. Submit worst case voltage drop calculations on control circuits.
   4. Submit material list for outlet boxes and cover plates. Cover plate proposed engraving identification schedule and description of proposed software program control operations, for each control circuit.
   5. Submit conformance documents indicating submitted equipment meet specifications exactly as stated or via an alternate mans indicating specific methodology used.

B. Substitutions: Under provisions of Division 1
   1. All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by the design professionals a minimum 10 working days prior to the bid date and must be made available to all bidders. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.
   2. Any substitutions provided by the contractor shall be reviewed at the contractor's expense by the electrical engineer at a rate of $200.00 per hour.
   3. By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring. The contractor shall provide complete engineered shop drawings (including power wiring) with deviations for the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.

1.03 QUALITY ASSURANCE

A. Manufacturer: Minimum 10 years experience in manufacture of architectural lighting controls.

B. Manufacturer's Quality System: Registered to ISO 9001: 2000 Quality Standard, including in-house engineering for product design activities.

C. Lighting control system components:
   1. Listed by [CE] [CSA] [NOM] [UL] specifically for the required loads. Provide evidence of compliance upon request.

PART 2 - PRODUCTS

2.01 GENERAL

A. Function
   1. The low voltage relay control system shall provide a complete and operable system to control lighting and related equipment indicated on the drawings.
   2. Each room or area connected to the control system shall be operable both separately and/or simultaneously with other rooms or areas without interfering or affecting the operation of the control system in any other form(s) or area(s) connected to the same system.
   3. Control wiring shall be in accordance with the NEC requirements for Class 2 remote control systems, Article 725, energy limited systems.
   4. As manufactured by Lutron Electronic Co., Inc. – Lutron-Eco System.

B. Emergency Operation
   1. Relays controlling circuits connected to emergency power supply systems (i.e., lighting battery inverters, engine generators, etc.) shall provide an automatic "turn-on" of the controlled circuits upon failure "loss-of-voltage" in the non-emergency incoming supply source.
   2. Provide automatic override of "off" controls and connection for "loss-of" incoming normal power "sensing" circuit in each respective control panel.
   3. Provide automatic override to turn all lighting circuits on when activated by the fire alarm system emergency "on" control.

C. Applicable Standards (Additional Requirements)
   1. Equipment and components shall be:
      a. UL listed and labeled.
      b. Certified for compliance with Federal-EPA and State of California Title-24 Energy Commission.

2.02 General EcoSystem Performance

A. Daylight Harvesting, Occupant Detection, Personal Control to control lighting with the following hierarchy:
   1. Emergency (Highest priority): Ignores all other inputs.
   2. Programming: During system programming, sensor inputs are ignored.
   3. Occupant sensor: Allows lights to be on/off.
   4. Daylight sensor: Imposes a high end limit for light output.
   5. Personal control: Fine tune light levels up to the daylight sensor limit.

B. Response to a single sensor can be unique on fixture by fixture basis.

C. Power failure recovery – All devices return to their previous light level prior to power loss.

D. All programmable devices have integral power failure memory to maintain settings for a minimum of 10 years during power loss.

E. Wall station and sensor replacement is accomplished without programming.

2.03 MANUALLY OPERATED CONTROL SWITCHES

A. Switch Function
   1. Switches shall provide manual on-off control of respective low voltage coil relay(s) indicated on the drawings.
   2. Switches shall control up to three parallel low voltage coil relays directly. Where more than three parallel relays are controlled by a single switch, a multi-relay sequential controller shall be provided between the switch and respective group of relays.
   3. Each switch control circuit shall provide a connection interface for supplemental control of lighting on-off operation by local motion/occupancy sensors located in the same area controlled by the respective manual switch. The motion/occupancy sensor locations shown on the drawings shall override the respective relay control manual switch on-off functions. The local manual "off" controls shall override the automatic "on" control feature of the respective occupancy motion sensor. Override of the automatic "off" feature of the occupancy motion sensor shall not be affected by the respective local manual switches.

B. Switch Configuration
   1. Each switch shall contain two push buttons, one button for "on" operation and the second button for "off" operation. Rectangular in shape (approximately 0.5-inch square each button) momentary contact, single pole double throw configuration, normally open contacts. Alternately, momentary contact 3-position, center-off combining on/off control functions into a single "toggle" assembly may be provided for each switch. Each switch rated a minimum of 3 ampere at 28 volts A.C. or D.C.
   2. Each switch shall be equipped with a back lighted "on" pilot light. Pilot light shall be "on" when respective relay(s) are "on" and "off" when respective relays(s) are "off". Pilot light lamp shall be LED type with not less than 50,000 hours minimum operation "on" operation life.
   3. Where more than one switch is shown installed at the same general location on the drawings, all switches at that same location shall be mounted in a common multi-gang outlet box and under a common cover plate. Cover plates shall be one piece stainless steel prepunched for switches. Switches shall be a maximum of 2-rows high. Switch plates containing more than (3)–three switches shall have "unpunched" "spare" blank space for the future installation of one additional complete switch. Provide engraving of cover plate to identify the area or equipment controlled by each switch as directed in the field.
   4. Switches controlling lighting or other equipment located in the same area/room shall be arranged in function groups adjacent to each other in the switch coverplate.
   5. Switches shall be white in color. Switches indicated as master switches on the drawing shall be blue. Switches controlling circuits connected to emergency electrical power source shall be red.

2.04 LOW-VOLTAGE WALL STATIONS

A. Product: EcoSystem 1B – Lutron Model CC-1BRL-WH EcoSystem 4B – Lutron Model CC-4BRL-WH.

B. General:
   1. Class 2 (low voltage).
   2. Integral IR receiver for programming.
   3. Immediate local LED response upon button activation to indicate that a system

command has been requested.

4. Wall stations can be replaced without reprogramming.
5. Color:
   a. Match NEMA WD1, Section 2 White.
   b. Color variation in same product family: Maximum ΔE=1, CIE L*a*b color units.
   c. Visible parts: Exhibit ultraviolet color stability when tested with multiple actinic light sources as defined in ASTM D4674. Provide proof of testing upon request.

C. One Button Control
1. Toggle on/off and master raise/lower control for group of fixtures.
2. "Press and Hold" button programming for creating and modifying groups.

D. Four Button Control
1. Recall 4 Scenes plus all on or all off for one group of fixtures.
2. Master raise/lower control entire group of fixtures.
3. "Press and Hold" button programming supports:
   a. Create and modify groups.
   b. Modify scene levels.

2.05 SENSORS

A. General:
1. Use Class 2 wiring for low voltage communication.
2. Can be replaced without reprogramming.
3. Constructed via sonic welding.
4. Color:
   a. Match NEMA WD1, Section 2 White.
   b. Color variation in same product family: Maximum ΔE=1, CIE L*a*b color units.
   c. Visible parts: Exhibit ultraviolet color stability when tested with multiple actinic light sources as defined in ASTM D4674. Provide proof of testing upon request.
5. Mountable on lighting fixtures or recessed acoustical ceiling tiles.

B. Infrared Receivers have 360 degree reception of wireless infrared remote controls.
1. Immediate local LED response upon reception of hand held transmitter communication.
2. Constructed with plastic meeting UL94 HB.

C. Interior Daylight Sensors:
1. Open-loop basis for daylight sensor control scheme.
2. Stable output over temperature from 0° to 40° C.
3. Partially shielded for accurate detection of available daylight to prevent fixture lighting and horizontal light component from skewing sensor detection.
4. Provide linear response from 0 to 500 foot-candles.
5. Integral IR receiver for programming.
6. Constructed with plastic meeting UL94 HB.

D. Occupancy Sensors
1. Connect directly to EcoSystem ballast, modules, and bus supply without the need of a power pack or other interface.

2.06 Hand Held Programmer

A. General
1. Wireless programming for all system settings.
2. Secured via pass code.
3. Replace ballast via serial number.
4. Only operates as a lighting control device.

5. Non-volatile memory stores lighting control software for minimum of 10 years for power loss.
6. Stores not system specific configuration settings

2.07 POWER INTERFACES

A. Product: [FDI-INC.] [FDI-ELV.]

B. Electrical:
1. Phase independent of control input.
2. Dimmer to meet limited short circuit test as defined in UL 20.

C. Diagnostics and Service: Replacing power interface does not require re-programming of system or processor.

2.08 ACCESSORIES

A. Tamper Proof Covers:
1. Locking covers for preset control units and wall stations: Reversible to allow lock to be located on either side of control.
2. Compatible with IR controls.

B. Infrared Transmitters:
1. Provide wireless remote control capable of recalling "on" plus "off", one favorite scene, and of fine-tuning light levels with master raise/lower.
2. Designed for use in conjunction with compatible infrared receiver and lighting control; dependent on that receiver, not transmitter.
3. Operate up to 25 feet (7.5 meters) within line-of-sight to that receiver.
4. "Learnable" by other variable frequency remote controls.

2.09 LOW VOLTAGE COIL LOAD CONTROL RELAY

A. General
1. Relays shall be single pole single throw maintained contact, load rated 20 ampere at 277 volt-single phase, 60Hz A.C. in 60 degrees centigrade ambient temperature.
2. Relays shall be rated full load capacity with Tungsten filament, electronic/induction lamp, ballast or resistive loads. 14,000 ampere symmetrical short circuit withstand rating in series with the upstream branch circuit protection devices. 0.5 HP motor load at 120 volt and 1.5 HP motor load at 220 through 277 volt.
3. Relay coil shall operate at 24 volt 60Hz AC or DC three wire, mechanical latching type, to open or close on receipt of a pulsed voltage to the coil.
4. Relay operation shall be gravity independent of relay physical position/orientation.
5. Relay auxiliary pilot contacts where remote pilot lights and/or remote relay on-off status monitoring is required on device(s) controlling the relay.

B. Relay Electrical Connections
1. Each relay with prewired insulated copper conductor pigtails for control circuit connection.
2. Each relays with two screw type terminals for connection of load wires #14 AWG thru #10 AWG, solid or stranded copper load circuit conductors.

C. Relay Quantity
1. Provide multiple relays for each branch circuit.
2. Total quantity of relays as required to perform the independent local switching control zones for each building area and multi-level lighting intensities control.
3. Control sequences as shown on the floor plans and as described herein.

D. Multi-Relay Sequential Controller
   1. Where multiple low voltage coil relays require control by a single control device action or mastering control device, a multi-relay sequential controller shall be provided.
   2. The controller shall sequentially turn the individual relays "on" or "off" when an on or off signal is input into the controller.
   3. The controller shall accept maintained normally open or momentary pulsed inputs from controlling devices to initiate the control sequence.
   4. Where one controller does not have adequate capacity to handle the indicated quantity of relays, multiple controllers shall be provided in "cascaded" sequence of operation.

2.10 POWER SUPPLY

A. General
   1. Control power transformers shall be rated 60 Hz, AC line voltage input, 75VA momentary and 40VA continuous control power load, 24 volt nominal secondary control source. Primary line voltage shall be as indicated on the drawings.
   2. A solid state rectifier shall rectify the 24 volt, 60 Hz transformer output to D.C. halfwave or fullwave.
   3. The relay control system shall operate at 24 volt D.C. nominal, and/or multiplex digital communications control.
   4. Power supplies shall be fused on the line side.
   5. Provide multiple power supplies as required to allow multiple simultaneous operation of relay control zones.

2.11 EcoSystem Bus Supply

A. General
   1. Connect without interface to:
      a. Occupancy sensors.
      b. Building management / integration contact closure outputs.
      c. Fire alarm or security system contact closures.
      d. Emergency lighting interface [Lutron LUT-ELI] listed to UL 924.
   2. Integral fault protection to prevent bus supply failure in the event of a mis-wire.
   3. LED status indicators:
      a. Bus supply is powered.
      b. Bus supply operating properly.
      c. Bus communication.
      d. Emergency condition active / non-active.
   4. Configuration switches:
      a. Override bus to full light output.
      b. Override bus to low end.
      c. Override bus to off.
      d. Closure inputs normally open/closed.
   5. Enable/disable system programming (lockout).

B. Field Mounted EcoSystem Bus Supply
   1. Integral clip for mounting on DIN rail.

C. Wall Mounted EcoSystem Bus Supply
   1. Provide digital bus power supply in a pre-assembled NEMA listed enclosure with terminal blocks listed for field wiring.

2.12 EcoSystem Ballast Module

A. General
   1. Continuous 3-Wire signal dimming to Lutron 3-Wire electronic dimming ballast.
   2. Connect without interface to:
      a. Occupant sensor (motion detector).
      b. Daylight sensor.
      c. Personal control input (wall station or infrared receiver).
   3. Generate digital communication commands to distribute ballast and sensor data on the digital bus.
   4. If power is interrupted and subsequently returned, lights automatically return to the setting prior to power interruption.
   5. Each ballast responds independently:
      a. Up to 64 occupant sensors.
      b. Up to 64 personal control inputs.
      c. An individual EcoSystem ballast can be configured to respond to 2 daylight sensors; however, an EcoSystem bus will support up to 8 daylight sensors. 2 daylight sensors.
   6. Unique internal reference number visibly displayed on module cover.
   7. Averages 2 independent daylight harvesting inputs internally.
   8. Responds to digital load shed command
      a. Sets high end trim.
      b. Automatically scales light output proportional to load shed command.
         1) Example: If light output is at 30% and a load shed command of 10% is received, the ballast automatically sets the maximum light output at 90% and lowers current light output by 3% to 27%.
   9. Electrical: Dimmer to meet limited short circuit test as defined in UL 20.
   10 Provide integral fault protection to prevent ballast module failure in the event of a mis-wire.

B. 2 Amp (BMF) 3-Wire Ballast Module
   1. Ballast module to integrate up to 2 amps of Lutron 3-wire electronic dimming ballast into an EcoSystem control system as a single zone.

C. 16 Amp (BMJ) 3-Wire Ballast Module
   1. Ballast module to integrate up to 16 amps of Lutron 3-wire electronic dimming ballast into an EcoSystem control system as a single zone.

2.13 CONTROL CABINETS

A. General
   1. The control cabinets shall contain, but not be limited to, the following components. Control cabinets shall be factory prewired, assembled, and tested:
      a. Low voltage coil relays.
      b. Power supplies.
      c. Multi-relay sequence controllers.
      d. Terminal strips, for each incoming control/load conductor connection.
      e. Control and load circuit wiring connections.
      f. Lighting and control automation.

B. Equipment Housing
   1. The cabinet housing shall be metal similar to branch circuit panelboard construction, with not less than two internally barriered and isolated sections. One Section shall contain the line voltage components and connections, the second section shall contain the low voltage control devices and components.

2. Low voltage coil relays shall be supported in the cabinet barrier divider, in an arrangement to allow ease of installation and replacement.
3. The cabinet shall be sized to accommodate a minimum of not less than 30 relays and 48 relays maximum, along with associated control components and power supplies. Maximum 22-inches wide x 5.75-inches deep x height as required. Provide hinged locking cover door. All components including operator controls shall be located behind the cover door. Provide additional cabinets for relay quantities exceeding 48 relays.

   Note: Relay control systems that employ "relay-packs" located remote from the branch circuit panelboards instead of relay cabinets located adjacent to the panelboard, shall also be permitted. The relay packs shall be UL listed for installation in environmental air plenums and above the ceilings shown on the contract documents. The remote relay packs shall perform the functions of the control cabinets. Provide the conduit and wire modifications recommended by the manufacturers for all electrical and control circuit connections for "relay-packs".

2.14 LIGHTING AND CONTROL AUTOMATION

A. General
   1. Provide separate independent control input ports for each remote manual control switch; each remote occupancy motion sensor; emergency controller input; fire alarm control input; and each remote automatic and/or manual control function device shown on the drawings or described in the contract documents.
   2. Each control input port shall be an independent communication channel assignable for control by the internal system software programming functions. Each individual relay and/or multiple groups of relays shall be controlled by software programming to respond to the "on-off" control functions.
   3. Additionally, provide four (4) spare unused control input ports for future connections, in each cabinet.

B. Lighting and Equipment Automatic On-Off Control
   1. The control system shall provide field programmable individual and/or group "automatic-off" and "automatic-on" lighting and equipment control of each individual relay contained in each lighting control panel.
   2. The automatic control system shall operate in conjunction with the manual-switch controls and related external control points such as fire alarm systems, emergency electrical systems, photo electric switches, EMCS/BAS equipment, etc.
   3. The on-off setpoints shall be field programmable in each control panel to provide distributed local control independent operation of each control panel. The automatic settings shall be stored in "non-volatile" memory in each control panel and shall be maintained in memory for a minimum of 180 days after the continuous loss of all normal input power to the control panel.
   4. The automatic "on-off" controls shall provide the following programmable control of each individual low voltage coil relay in each control panel. The automatic controls shall function individually or in any combination with each other:
      a. Time-of-day "on" and "off" with not less than (8)-independent "on" or "off" operations each day for each separate relay each day.
      b. Separate independent special event, weekday, weekend, holiday, daylight savings and leap year program settings.
      c. Perpetual internal calendar not less than 30-year range, for day and date automatic control functions.
      d. Astronomical – Time clock function, to provide automatic calculation of sunrise and sunset based on date and geographical location for automatic on-off scheduling. The time-clock function shall also provide normal time clock lighting control functions, without the astronomical time clock adjustment function for selected relay circuits.

e. Photo electric switch, dry relay contact inputs to provide automatic "turn-on" and "turn-off" of each lighting control relay designated for "day-lighting", "night light" and/or "security light" photocell control lighting zone controls. The photoelectric switch control sequence shall function in conjunction with the normal time-clock control sequence. Momentary or maintained photo electrical cell relay control.

f. Fire alarm system dry relay contact input to provide automatic "turn-on" during a fire alarm condition, of each lighting control relay designated and/or connected to the lighting control panel.

g. Remote occupancy motion sensor input for automatic on-off control of each respective area monitored by each sensor.

5. Window area "daylighting" control.
   a. Separate "daylight" photosensor analog input 1 through 10 volt AC or DC variable input range, for each lighting control zone (room) where daylight photo sensor is shown on the drawings.
   b. The "daylight" control shall automatically turn on/off and/or dim lighting fixtures located in the daylighting area of each lighting zone, independently of the remaining light fixtures located in the same lighting zone. Each "daylight zone on/off and/or dimming function shall be controlled by the light intensity as measured by the respective photo sensor.
6. Blink alert.
   a. Prior to any lighting control relay automatic "off" event, lighting loads that are "on" or are manually turned on during automatic off sequences and are assigned with blink-alert, shall be momentarily turned "off" then back "on" twice, to alert occupants.
   b. User override of the automatic-off operation by activating the respective circuit local manually operated control interface. The time-out duration of the override time delay of the automatic-off shall be field programmable 15-120 minute, before resuming the blink alert sequence. At the end of the time-out, the blink-alert sequence shall repeat continuously for the respective relay circuit.
   c. The blink-alert shall not function for the following relay circuits:
      (1) Relays that are already in the "off" condition.
      (2) Relays that are under control of the "daylighting control", "fire alarm" or "emergency" controls.
      (3) Relays that control night lighting or security lighting circuits.
      (4) Relays that control H.I.D. type lighting fixtures.
      (5) Occupancy motion sensors switch automatic "off" functions.
      (6) Non-lighting circuits.
7. Occupancy motion sensor control, to override respective local manual switch "on-off" relay control in the same control area as the motion sensor:
   a. "Automatic off" – override "off" to automatically turn "off" all relays that are turned "on" by the respective local manual switch controls.
   b. "Automatic-on" – override "on" to automatically turn "on", software program selected relays that have been turned "off" by local manual switch control.
8. Central dimming control system.
   a. Handheld lighting control system.
   b. Low voltage wall stations and control interfaces and sensors.
   c. Solid-state high frequency fluorescent dimming ballasts.

2.16 SOURCE QUALITY CONTROL

A. Perform full-function testing on all completed at end of the Statistical sampling is not acceptable.

B. Diagnostic and Service – Tiered control scheme for dealing with component failure that minimizes loss of control for occupant.

1. Bus failure: Lights go to emergency level for safety.
2. Failure of one sensor type: Ballast still controllable via other sensors.
3. Ballast failure: Only impacts one fixture – remainder of system operates as programmed.

PART 3 – EXECUTION

3.01 GENERAL

A. Commissioning (Additional Requirements)
   1. Setup, testing, startup, and commissioning shall be performed by factory technician(s) trained, certified and authorized by the equipment manufacturer. Final commissioning shall be performed after installation and connections are complete.
   2. Provide system programming and setup of all control sequences and each lighting control bone for the lighting control system.
   3. Test all control system functions after the installation and connections are complete and the system has been energized. Verify each control sequence of operation and each device to be controlled are each operating correctly.
   4. Record and document each device setup and program setting.
   5. Verify interconnection and controls with the:
      a. Lighting control systems.
      b. Fire alarm/emergency life safety systems.
      c. Security/intrusion detection system.
      d. Building automation system (BAS) and energy management control systems – EMCS.
   6. Submit written report (6 copies) to OWNER's Representative certifying commissioning has been performed; all respective systems are operating correctly and document all software setup and each device settings.
   7. Demonstrate and educate OWNER's Representative on system capabilities, operation and maintenance.

B. Special Project conditions
   1. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
      a. Ambient temperature: 0□ to 40□ (32□ to 104□F).
      b. Relative humidity: Maximum 90 percent, non-condensing.
      c. Lighting control system must be protected from dust during installation.

3.02 CONTROL CABINETS

A. General
   1. Control relay cabinets shall be installed directly adjacent to respective branch circuit lighting panelboard. Cabinet shall be flush or surface mounted to match the respective panel. Provide dedicated control relay cabinet(s) for each branch circuit panelboard with low voltage remote control relays. Do not "share" a control relay cabinets among multiple branch circuit panelboards
   2. Provide a minimum of three (3) 3-inch conduits between the cabinet and respective panel and provide the branch circuit conductors.
   3. The cabinet section directly adjacent to the panelboard providing the line side branch circuit connections shall contain the line voltage compartment.
   4. Each cabinet shall have two spare relays installed and space for two future relays. Each cabinet shall have four (4) spare unused control input ports for future external control inputs.
   5. Provide 2#12 (AWG) copper THHN/THWN 600 volt insulated conductors from each control panel to the control power branch circuit breaker in the respective panelboard for the control panel control power source.

3.03 OUTLET BOXES (ADDITIONAL REQUIREMENTS)

1. Provide multi-gang outlet boxes with coverplates for installation of manually operated control switches.
2. Install all control devices located remote from the control panels in outlet boxes.

3.04 WIRING (ADDITIONAL)

A. General

1. Neatly lace, train and rack wiring in cabinet.
2. All control wire conductors shall be terminated on isolated, terminal strips.
3. The low voltage control and communications circuits shall not route through the line voltage branch circuit panelboard.
4. All control wiring for runs exterior to the cabinets shall be provided with spare conductors sufficient to include the operation of two (2) additional future control devices.

B. Control Circuits

1. The CONTRACTOR shall provide the quantity and type of control wire required for proper system operation, as recommended by the system manufacturer. Install all control circuits in conduit.
2. Control wire shall be copper #18 AWG minimum, twisted pairs, PVC insulated for control voltage, color coded to match relay and switch wiring "pigtail" color codes. Control wiring shall be rated for installation in a environmental "air-plenum".
3. Network communications wires shall be ANSI/EIA/TIA-568B, 100-OHM, 4-pair shielded twisted pairs STP, Category-5E or as recommended by the system manufacturer.
4. Where multiple control wires are installed in a single conduit or route to a single location provide multiconductor control cables with outer jacket; except control wires for control of multi-relay sequential controllers which shall be separate twisted shielded three wire PVC insulated conductors, with a ground wire and outer jacket for each controller to prevent "RF" interference.
5. Control wire shall be increased in wire gauge size as required to insure proper system operation and voltage drop over the installation distance shown on the drawings between equipment and control device locations.

3.05 MAINTENANCE

A. Make ordering of new equipment for expansions, replacements, and spare parts available to end user.

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

C. If there is a problem on the job site, the manufacturer must be reachable 24 hours per day / 7 days a week to resolve any lighting control issues. If this service is not provided, project cost overruns and delays can occur. Additionally, answering services can add to frustration and delays. Provide factory direct technical support hotline 24 hours per day, 7 days per week.

3.06 WARRANTY

A. Ballast warranty is specified in section 16500 – Fluorescent Electronic Dimming Ballasts.

B. A standard EcoSystem module warranty is 3 years; however, when purchased with Lutron system startup, the warranty of a Lutron module is extended to 5 years. See additional system specification sections for more details if EcoSystem is included as part of a larger Lutron System. Provide manufacturer's warranty covering 3 years with Lutron startup on

EcoSystem modules from date of purchase.

C. Provide manufacturer's Enhanced 8 Year Limited Warranty for daylight sensors, occupancy sensors, wall stations, bus supply, and infrared receivers:
   1. 8-year limited parts warranty for the replacement of defective lighting components from the date of system startup completion.
   2. 2-year Silver Level Support and Maintenance Plan that covers 100% parts and labor from the date of the system startup completion.

D. Provide manufacturer's full 1 year warranty covering 100% parts and 100% labor from the date of system startup completion.

3.07 IDENTIFICATION (ADDITIONAL REQUIREMENTS)

A. General
   1. Each relay shall have an identification tag indicating the originating branch circuit number and panelboard name along with the relay name as indicated on the drawings.
   2. Each line side branch circuit conductor shall have an identification tag indicating the branch circuit number and source panel name.
   3. Each low voltage control wire and terminal shall have an identification tag indicating switch or control device name and relay controlled as indicated on the drawings.
   4. Provide a point to point wiring diagram on the inside over of the control cabinet.
   5. Each manually operated control switch shall be provided with engraved identification describing devices and areas controlled by the respective switch.

END OF SECTION

SECTION 16931

OCCUPANCY MOTION SENSORS

PART 1 - GENERAL

1.01 SCOPE

A. Work Included: All labor, materials, appliances, tools, equipment necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete, as shown on the drawings and/or specified herein. Work includes, but is not necessarily limited to the following:
   1. Examine all other specification sections and drawings for related work required to be included as work under Division Sixteen.
   2. General provisions and requirements for electrical work.

1.02 SUBMITTALS

A. Submit data sheets on sensors, wiring diagrams, relays, transformers, junction and outlet boxes, and mounting accessories. Submit wiring diagrams. Submit agency certifications/approvals.

B. Submit details of pendant-mounted sensor installation.

1.03 APPLICABLE STANDARDS (ADDITIONAL REQUIREMENTS)

A. General
   1. All ultrasonic sensors shall comply with the State of California Safety and Health Requirements. Decibel levels for ultrasonic sensors shall comply with the following criteria and the State of California Energy Commission for ultrasonic emissions:

MAXIMUM DECIBEL LEVELS
FOR ULTRASONIC EMISSIONS

Midfrequency of Sound Pressure Third-Octave Bank (kHz)	Minimum dB Level Within Third Octave Band (in dB reference 20 micropascals)
Less than 20	80
20 or more to less than 25	105
25 or more to less than 31.5	110
31.5 or more	115

   2. The CONTRACTOR and manufacturer shall certify in writing that all proposed and installed occupancy motion sensors comply with the Federal Environmental Protection Agency (EPA) and State of California Energy Commission criteria.
   3. Occupancy motion sensors shall be:
      a. UL listed and labeled.
      b. Certified for compliance with Federal-EPA and State of California Title-24 Energy Commission Requirements.

PART 2 - PRODUCTS

2.01 MOTION SENSORS

A. General

1. Motion sensors and power supply shall be self-contained. The motion sensors shall be solid state low voltage devices designed specifically for energy conservation lighting control. Combined dual function ultrasonic and infrared motion sensing.
   a. Ultrasonic crystal controlled to within +/- 0.01% motion sensor technology.
   b. Passive infrared (PIR) motion sensor technology.
2. Occupancy motion sensor shall also include available ambient light sensor, in addition to the motion sensor. The ambient light sensor shall prevent the occupancy motion sensor from automatically turning "on" the respective lighting when the ambient daylighting intensity detected by photoelectric cell contained in the motion sensor exceeds a selected intensity. (The ambient light sensor circuit shall <u>not</u> control the automatic off function. The ambient lighting intensity detection sensitivity shall be adjustable in the sensor, adjustment range not less than 15 through 140 ambient daylighting footcandles.
3. Automatic-off: sensor shall automatically turn "off" lighting when there is no movement after the preset time delay interval. Lights shall remain "on" with movement. There shall be a "dead band" time period after the unit turns itself off (because of lack of motion) during which a new motion will automatically turn lights on without the manual switch having to be activated.
4. Automatic-on: Ceiling mount sensors shall automatically turn "on" lighting when movement is detected in the monitored space. Lights shall remain on with movement. An internal control shall provide a mechanism to bypass the automatic-on control feature and allow only automatic-off functions. Where manual on/off [dimming] lighting control switches are shown on the drawings, in addition to the occupancy motion sensors in the same space, the manual controls shall override the automatic "on" control feature of the occupancy motion sensor. Override of the automatic "off" feature shall not be affected by the respective manual switches.
5. Motion detection sensitivity, time delays to turn "ON" after activation and time delays to turn "OFF, shall be adjustable to ensure there will be no nuisance on/off switching of the lights by the motion sensor while the room is occupied. Adjustable settings shall be tamper resistant, concealed behind an access protection cover.
   a. Fluorescent light fixtures with Instant Start or Rapid Start lamp ballast, set the minimum lamp "on" time at not less than 15-minutes. Program Start lamp ballast, set the minimum lamp "on" time at not less than 5-minutes.
6. Fail-to-on, the failure of a sensor shall cause the occupancy motion sensor load relay contacts to activate, so the occupancy motion sensor function is automatically bypassed and lighting is turned-on.
7. All occupancy motion sensors shall be provided with an indicator light to display when motion is being detected and the unit is operating correctly.
8. Non-volatile internal memory shall store and maintain in memory all occupancy motion sensor settings during any electric power failure.
9. Where multiple occupancy motion sensors are installed with overlapping monitoring spaces, the sensors shall not cause false triggering or malfunctions to adjacent occupancy motion sensors.
10. Occupancy motion sensors shall incorporate mechanical vibration-damping. The vibration-damping shall prevent normal building vibrations from causing "false" sensor operation.
11. As manufactured by Novitas; Leviton; or Hubbell.

B. Area Control Coverage

1. Space coverage of motion sensor transponder shall remain constant after sensitivity control has been set. No automatic reduction/increase in coverage nor sensitivity shall occur when air motion caused by air conditioning or heating fans are in operation nor when the occupancy motion sensor has turned off lighting due to not detecting any motion.
2. Occupancy motion sensors in spaces 300 square feet area or less may be a wall switch mounted unit.
   a. Wall switch sensors shall provide detection of motion at desk top, for up to 300 square feet,
      180-degree range within a volume dimension of up to approximately 20 ft. x 15 ft. x 10 ft. high, extending from the wall mounting height of the unit to the finish floor.
   b. Wall switch occupancy motion sensors shall be a minimum load capacity of 500 watts 120V; 1000 watts 277V, but in no case shall the load rating be less than the lighting loads shown on the drawings.
   c. The wall motion sensor switch shall be provided in place of the manual control switch(es). Wall switch occupancy motion sensors shall be equipped with manual override internal switch accessible on the front of the enclosure housing. The internal manual override switch shall turn "on" the lights and turn "off" the lights when manually activated.
3. Motion sensors in spaces exceeding 300 square feet in size and where shown on the drawing as mounted on the ceiling, shall be ceiling mounted. The sensor shall not protrude more than 1.6-inches below the ceiling line.
   a. Sensor area coverage shall be 360 degrees three dimensional diameter surrounding the sensor installation location.
   b. The sensor shall be rated to provide coverage of the space volume/room length/width/height shown in the contract documents. Provide additional ceiling mounted motion sensors to provide complete coverage of each area.
   c. Corridor/hallway sensor area coverage shall not be less than 80 ft. linear feet extending from the sensor installation location. Sensor shall be bi-directional or uni-directional to provide complete area motion detection at the installation location shown on the drawings.

2.02 CONTROL UNITS

A. General
1. Control unit shall be an integrated, self-contained unit consisting internally of load switching control relay(s); internal power supply and power supply transformer. The power supply shall be sufficient capacity to provide low-voltage power to a minimum of two (2) motion sensors.
2. Occupancy motion sensors directly controlling line voltage electrical loads, the line voltage load relay contacts shall be "dry" type electrically isolated, with load ratings as follows:
   a. 15A - 120 volt single phase 60 Hz AC.
   b. 15A – 277 volt single phase 60 Hz AC.
3. Load relay contacts shall be rated to control load types up to the full ampere rating. Incandescent Tungsten lamps for lighting equipment. Rapid start and instant start and Program Start solid state electronic ballast (both low power factor and high power factor) for lighting equipment.
4. The quantity of individual internal load switching relays shall be not less than the quantity of individual "switchleg" circuits to be controlled shown on the drawings.

B. Occupancy motion sensors that connect to low voltage remote control relays (LVRCR) systems.
   1. LVRCR systems and occupancy motion sensor shall be rated and certified by the occupancy sensor manufacturer and the LVRCR manufacturer for proper operation with the LVRCR control port inputs and the occupancy motion sensor control output interface relay contacts. Occupancy sensor normally open, normally closed, maintained control relay contact, momentary control relay contact, control operation sequences in coordination with the LVRCR requirements for automatic "on and off" load control by the LVRCR.
   2. The occupancy motion sensor power supply input, voltage rating and current rating control interface shall comply with LVRCR requirements.

2.03 OCCUPANCY MOTION SENSOR HOUSING ENCLOSURE

A. General
   1. Enclosures for occupancy motion sensor control units shall be pressed steel or high impact resistant nonflammable non-metallic enclosure. Enclosure finish color white. Semi-flush mounting installation, NEMA I "dead front" construction with mounting plates and barriers to provide separation between line voltage and low voltage wiring.

B. Mounting
   1. Flush mounting 4.67-inch square x 2.125-inch deep outlet junction box with extension ring and occupancy motion sensor cover mounting plate.
   2. Occupancy sensor shall be semi-flush mount into outlet box with tamper resistant attachment of the sensor and the outlet box.
   3. Motion sensor shall be approved for installation in environmental air plenum.

PART 3 – EXECUTION

3.01 MOTION SENSOR QUANTITIES AND TYPES

A. General
   1. The CONTRACTOR shall provide the quantity and types of motion sensors required for complete and proper volumetric coverage without gaps within the range of coverage(s) of controlled areas.
   2. Rooms shall be ninety (90) to one hundred (100) percent volumetric coverage of the sensing coverage area, to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). Motion sensing detection coverage shall extend from the finish floor to not less than 48-inches above finish floor.
   3. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only rooms which are to be provided with sensors. The CONTRACTOR shall provide additional sensors if required to properly cover the respective rooms.
   4. Ceiling mounted sensors shall also be pendant-mounted in rooms in which the controlled lighting fixtures are chain, cable or pendant suspension mounted. The mounting height of the sensor shall be approximately 6-inches below the bottom of the light fixtures to be controlled.
   5. Wall mounted sensors shall be installed at a height not higher than the bottom of the respective ceiling lighting fixtures. For Wall switches with integrated manual switch for "on" or "off" applications, mounting height shall not exceed 42-inches above finish floor.
   6. Occupancy sensors may be affected by various conditions in the room. Make adjustments, change the location and/or type of occupancy motion sensor to obtain proper operation in each specific room location.
   7. Install occupancy motion sensors a minimum of 72-inches horizontal distance from environmental air supply/return registers, fans and moving objects.

3.02 SETUP AND TESTING

A. Commissioning (Additional Requirements)

1. Setup, testing, startup and commissioning shall be performed by factory technician(s) trained, certified and authorized by the equipment manufacturer. Final commissioning shall be performed after installation and connections are complete.
2. Provide system programming and setup of all control sequences for lighting control system.
3. Adjust sensitively, time-delay, location and orientation of each occupancy motion sensor; test each sensor/control unit all in accordance with the manufacturers recommendations. Be certain that no obstructions block proper sensor coverage of detection areas and limit sensor pickup zone to the respective room.
4. Test all control system functions after the installation and connections are complete and the system has been energized. Verify each control sequence of operation and each device to be controlled are operating correctly.
5. Verify interconnections and controls with the:
   a. Lighting control systems.
6. Record and document each sensor setup and program setting.
7. Submit written report (6 copies) to OWNER's Representative certifying commissioning has been performed; all respective systems are operating correctly and documenting all software setup and each device settings.

3.03 WIRING (ADDITIONAL REQUIREMENTS).

A. General

1. The drawings do not indicate the quantity of control wires required between various control points. The CONTRACTOR shall provide the quantity and type of control wire required for proper system operation, as recommended by the system manufacturer. Install all control circuits in conduit.
2. Control wire shall be copper #18 AWG minimum, twisted pairs, PVC insulated for control voltage, color coded to match relay and switch wiring "pigtail" color codes. [Control wiring shall be rated for installation in an environmental "air-plenum".]
3. Network communications wires shall be ANSI/EIA/TIA-568B, 100-OHM, 4-pair shielded twisted pairs STP, Category-5E.
4. Where multiple control wires are installed in a signal conduit or route to a single location provide multiconductor control cables with outer jacket. Control wires for control of relay controllers which shall be separate twisted shielded four wire PVC insulated conductors, with a ground wire and outer jacket for each controller to prevent "RF" inference.
5. Control wire shall be increased in wire gauge size as required to ensure proper system operation and voltage drop over the installation distance shown on the drawings between equipment and control device locations.
6. Occupancy motions sensor control power shall be powered from line voltage "hot" non-switched, lighting branch circuit. Alternately, control power may be obtained directly from the respective lighting control panel (if available). Provide two additional #12 (AWG) "hot-circuit" and neutral unswitched conductor in conduit homeruns and branch circuits.
7. All wiring shall be installed in conduit.

3.04 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace any fire alarm component devices or any hardware that is part of the system or devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 4 years from date of substantial completion.

END OF SECTION