

READ THIS FIRST

Notice to the Design Engineer, this document is part of Facilities and Infrastructure standards for Electrical Systems. Designers are advised to NOT use this template (*.doc) document as part of any project contract documents. Designers shall use the Port of Seattle MasterSpec specifications from the following link:

<https://www.portseattle.org/page/guide-specifications>.

Designers shall edit the corresponding Port's MasterSpec specification to meet the F&I Electrical Standard outlined in this specification. Note that Port's MasterSpec specifications contain specifications and languages for both Aviation and Maritime Divisions. F&I Standards are strictly for Aviation Division, and any Maritime related specs or languages should be removed from the project specifications.

PART 1 - GENERAL

1.1 SUMMARY OF WORK

- A. The extent and location of "Lighting Controls" Work is shown in the Contract Documents. This section includes the following:
 - 1. Lighting control sensing and utilization devices.
 - 2. Programmable lighting control systems, and relay panels.
 - 3. Illumination level and motion sensors.

1.2 GOVERNING CODES, STANDARDS AND REFERENCES

- A. NFPA 70 (National Fire Protection Association) - National Electrical Code,
- B. NFPA 101 (National Fire Protection Association) - Life Safety Code
- C. UL 916 Standard for Energy Management Equipment
- D. UL 924 Standard for Emergency Lighting and Power Equipment
- E. Washington State Energy Code, 2015, Commercial Provisions

1.3 SUBMITTALS

- A. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.
- B. Coordination Meetings
 - 1. Conduct coordination meeting with the Port PEST group as follows:
 - a. One meeting prior to submittal assembly to identify products and provide system overview

- b. One meeting with the Port PEST group to review Port comments
 2. Provide 30 days' notice prior to meeting
- C. Submittals shall include the following:
 1. Product Data: Include dimensions and data on features, components, and ratings for dimming controls. Include elevation views of front panels of control and indicating devices and control stations. Also include the following:
 - a. List of drivers and lamp combinations compatible with associated digital fixture interface and with dimmer controls, by manufacturer and catalog number.
 - b. Sound data, including results of operational tests of dimming controls.
 - c. Operational documentation for software and firmware.
 2. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on Project. Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
 - a. Engineering calculations for data communication rates, response time, network compatibility, network power delivery, and similar system performance considerations.
 - b. Wiring Diagrams: Detail specific systems tailored to this project and differentiate between manufacturer-installed and field-installed wiring. Engineering calculations for data communication rates, response time, network compatibility, network power delivery, and similar system performance considerations.
 - c. Diagrams for field installed wiring shall include interconnection between panels and typical wiring for devices. Include wiring label schedule for all field wiring.
 3. Manufacturer Certificates: Signed by manufacturers certifying that they comply with requirements.
 4. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
 5. Maintenance Data: Include operation and maintenance manuals.
 6. Warranties: Special warranties specified in this section.

1.4 QUALITY ASSURANCE

- A. Listing and Labeling: Provide electrical components, devices, and accessories that are Listed and Labeled as defined in NFPA 70, Article 100 and marked for intended use for the location and environment in which they are installed.
- B. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.
- C. Comply with NFPA 70, as adopted and administered by the Authority Having Jurisdiction.
- D. UL Listing for the Lighting Control components is required.

1.5 SPECIAL WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Port of other rights Port may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of dimming controls that fail in materials or workmanship within specified warranty period.
- C. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All products shall be listed and labeled for intended location and application. Where listing standards are unavailable products shall be field inspected in a manner acceptable to the authority having jurisdiction.
- B. All products mounted in ceiling spaces shall be suitable for use in an air plenum.
- C. Lighting controls shall integrate with the light fixtures to provide the performance required by the Washington State Energy Code-2015, Commercial Provisions, C405.

2.2 DEVICES-LINE CONTROL

- A. Photocells - outdoor
 - 1. Manufacturers:
 - a. Acuity
 - b. PLC Multipoint
 - c. Intermatic
 - d. Leviton
 - e. F&I Approved Equal.
 - 2. Description: Solid state, with dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
 - 3. Level Monitoring Range: 1-5 fc on, 3-15 fc off, with an adjustment for turn-on and turn-off levels within that range.
 - 4. Delay up to two minutes to prevent false switching.
 - 5. Enclosure: Heavy-duty die cast zinc, gasketed for maximum weather protection.
 - 6. Cell: Closed output contact or active signal between dusk and dawn.
 - 7. Temperature range: -40°F to 140°F.
- B. Occupancy Sensor

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1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acuity
 - b. Leviton Manufacturing Co., Inc.
 - c. Lutron Electronics Co., Inc.
 - d. Watt Stopper.
 - e. F&I Approved Equal.
 2. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
 - a. Performance: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes. Provide programming for manual-auto-off in accordance with user application requirements.
 - b. Sensor Output: Communication to line switching devices or contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the line or an auxiliary source such as a power pack.
 - c. Mounting:
 - 1) Finish Color: As selected by Port, white unless noted otherwise.
 - 2) Sensor: Suitable for mounting in any position on a standard outlet box.
 - 3) Relay: Externally mounted in a standard electrical enclosure.
 - d. Indicator: LED status lights to show when motion is detected during testing and normal operation of sensor.
 - e. Bypass: Override to "on" function in case of sensor failure.
- C. Power Pack: Dry contacts rated for use on LED loaded circuits protected by 20 amp circuit breakers at 120- and 277-V ac. Communication with sensing and controlling devices as determined by system architecture and protocol. Listed per UL 924 on egress lighting circuit applications.

2.3 PROGRAMMABLE CONTROL SYSTEM

- A. Subject to compliance with the specification, provide a lighting control system that integrates the performance of sensors, light fixtures, and programmable timing set points by one of the following:
1. Acuity
 2. Hubbell
 3. Lutron
 4. F&I Approved Equal.
- B. Performance: Input signal from digital signal sources is received by devices with a Digital Addressable Interface and subsequently switches or dims light fixtures or relays via a field interface device.
1. Each fixture, sensing and control device is connected to a digital data bus and has a unique address enabling exchange of information and/or receipt of action commands from other devices on the data bus.
 2. Peer to peer device communication

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3. Addressable devices can be programmed to channels or groups for receipt of common commands or actions.
 4. Response time: Response time from lighting control program, sensor, or control device signal initiation to user device (fixture interface, powerpack, load controller, addressable relay) corresponding action shall be less than 500 milliseconds.
 5. Comply with 47 CFR, Subparts A and B, for Class A digital devices.
 6. Control devices shall consist of photosensor control modules, switches, occupancy sensors and/or other low-voltage control devices.
 7. All components and assemblies shall be factory pre-tested prior to installation.
 8. Remote panels are to be UL listed under UL 916 energy management equipment.
 9. All assemblies are to be in compliance with FCC emissions standards specified in Part 15, Subpart J, for Class A application.
 10. Architecture: Indicated technical architecture may vary with specific manufacturer subject to compliance with the performance aspects of this specification.
 11. Digital Addressable Interfaces for luminaires being provided with emergency power are to be UL 924 rated and are to bring attached luminaire to full brightness upon loss of normal power regardless of status of local or programmed controls.
- C. Lighting Control Panel
1. Lighting control panels shall contain components required by system functionality. Provide 20% minimum spare relays and dimming cards for future use.
 2. General
 - a. Comply with UL 916
 - b. Heat dissipation method shall keep heat accumulation below the ambient rating of components. If vents are used, they shall have replaceable filters.
 3. NEMA 1 Full hinged front door with key lock handle.
 4. CAT 5e and power wiring separation with channels
 5. Side channel contains RJ 45 port for connection of laptop to Bridge.
 6. Power:
 - a. Incoming control at 120VAC. Surge suppression per UL 1449, SPD type 2.
 - b. Internal DC power supply appropriate to network and data bus consumption. Separately fused outgoing circuits or individual midpoint controllers for Cat 5 wiring.
 7. Bridge: Communication network for marshalling signals between Data Controller, Digital Fixture Interfaces, Graphic User Interface, Sensors, and related devices via the data bus. Communication to data bus via RJ-45 ports.
 8. Digital Addressable Relay: DIN Rail-mounted. Accept data bus signal for on/off operation of 277V, 20A, LED lighting circuits. Incoming power wiring shall land on terminal blocks prior to connecting to relay.
 9. Local Graphic Display: Provide Local Graphic Displays as needed based on the programming ability of the display and the number of controlled elements supported by the Lighting Control Panel. Mount on door.
 10. Digital Controller
 - a. Microprocessor based digital controller,
 - b. Function:
 - 1) Establishes time based controls and facilitates programming of network devices
 - 2) Links to a central control network via ethernet.

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- 3) Isolates local network (zone) and maintains distributed intelligence functionality if upon loss of system wide controls.
 - 4) Polls individual components for status, logs components failing to respond
 - 5) Server for software.
 - c. A central controller shall not be necessary for operation. Network shall utilize distributed intelligence. Source, switching and controlling device program parameters shall be retained at the device.
 - d. Gateway to central control network: Integral to Digital Controller or separate, per manufacturer.
- D. Data Bus:
1. Performance: Data signals transmitted over CAT 5e cabling. Cable terminated at each end with RJ 45 8 pin modular plugs, daisy chain connected from device to device.
 2. CAT 5e cable:
 - a. 4 Pair, 23 AWG, TIA 568-C.2 compliant. Color coding identified by Port, as an augmentation to the present Port standard.
 - b. As above with spiral wrapped aluminum armor, plenum rated, see PART 3.
 3. NEC Class 2 power circuit.
 4. Protocol specific to manufacturer, may utilize IEEE RS-485.
- E. Control and Utilization Devices
1. General
 - a. Each device connects to the digital data bus and has a unique digital address. Digital address shall be self-programming or set at the factory. Device addresses shall be self-populating on the network controls.
 - b. Power:
 - 1) From utilization component (relay, fixture, etc.) or
 - 2) Direct from data bus, consumption less than 0.2 watts per device
 - c. Data Bus: Two RJ-45 jacks for daisy chain connection of CAT 5e wiring.
 - d. Finish Color: As selected by Port, white unless noted otherwise.
 2. Switch, Momentary
 - a. Provides cycling on off signal
 - b. Switches at hold room podium shall be programmed to toggle on off control of all fixtures in the programmed zones.
 3. Photosensor – (Indoor)
 - a. Performance:
 - 1) Provides digital signal proportional to daylight
 - 2) Self-calibrated dead band, with manual min max override
 - 3) Dual zone control of primary and secondary daylight zones, programmable tracking offset of levels.
 - 4) Light-Level Sensor Set-Point Adjustment Range: 3-1000 fc
 - 5) Provide programming for manual-auto-off in accordance with user application requirements
 - b. Ceiling mount, 360 degree coverage
 4. Occupancy Sensor

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- a. Performance: Digital signal to turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes. Provide programming for manual-auto-off in accordance with user application requirements.
 - b. Configure with lens or field determination of sensing appropriate to area being controlled.
 - c. Mounting:
 - 1) Sensor: Suitable for mounting in any position on a standard outlet box.
 - 2) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 - 3) Ceiling-mounted.
 - d. Technology: Comply with one of the following:
 - 1) Detect occupants in coverage area using PIR and ultrasonic detection methods. Trigger of either technology, turns lights on. Both technologies must detect vacancy for lights to turn off.
 - 2) Detect occupants in coverage area using PIR and microphonic detection methods. Trigger of either technology, turns lights on. Both technologies must detect vacancy for lights to turn off.
5. Sensor Calibration: Comply with one of the following:
- a. Remote wireless calibration interface: handheld device with graphic screen. Furnish a quantity of 4 for the system.
6. Digital Fixture Interface (DFI)
- a. Performance: Accepts dimming level signal from data bus and provides LED driver with corresponding signal to vary light output. Digital signal provides complete "off" of power to LEDs. Individually programmed to respond to selected sensing and control devices such as photosensors, switches, and/or central time clock settings. Receives and locally stores programming parameters from the network via the Digital Controller/Software.
 - b. Loss of control signal shall result in either maintaining the last received input setting or full energization.
 - c. Fixtures identified on the lighting fixture schedule as requiring a digital fixture interface shall comply with one of the following:
 - 1) Embedded Device: Interface included by manufacturer in conjunction with fabrication of fixture. Load Controller: Provided immediately adjacent to and as part of the outlet box the fixture is connected to. Load controller output compatible with LED driver and wired accordingly.
 - 2) Load Controller: Provided immediately adjacent to and as art of the outlet box the fixture is connected to. Load controller output compatible with LED driver and wired accordingly.
 - d. Fixtures identified as DMX shall include a DFI with a DMX protocol conversion.
7. Local Graphic Display
- a. Interface with network for local override of time clock or photosensor controls.
 - b. 3.5 inch touchscreen input.
 - c. Sixteen on/off/dim control set points. Program as directed by owner concurrent with system training.

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- d. Password protection
 - e. RJ-45 network connections.
 - f. Receives programming set points and commands via the network and the Digital Controller/Software.
8. Power Pack:
- a. Class 1 relay with 0-10 volt output for control of LED fixture(s)
 - b. Mounted in Lighting Control Panel.
9. Emergency/Egress switching devices shall comply with UL 924.
- F. Network
- 1. Performance: Intercommunication among Digital Controllers for programming and time clock based communication
 - 2. TCP/IP over Ethernet.
 - 3. A personal computer running manufacturer furnished interface software shall be able to program the entire system via an Ethernet connection at any point on the central network. Furnish two laptop computers and 6 software licenses.
- G. Software:
- 1. Software shall utilize a web based, menu driven, graphic interface to facilitate programming of individual control and utilization devices. Access shall be through any computer connected to the network using a standard internet browser, such as Microsoft Internet Explorer or Apple Safari.
 - 2. Auto discovery of all devices on the network.
 - 3. Any sensor or switch in a group shall be able to be programmed to any digital fixture interface device.
 - 4. Software shall allow grouping of devices for time control parameter entry.
 - 5. Software shall permit real time adjustment of device status.
 - 6. Software shall have 24 hour timing provisions (Programming provisions for weekends, holidays and similar events is unnecessary as the airport operates under identical schedule 365 days a year.)
 - 7. Groups of fixtures may be programmed for 24 hour start-stop times with automatic adjustment for daylight savings time, or based on local programmed sunrise-sunset times.
 - 8. Programming shall accept local override based on inputs from the Local Graphic Display. Period of time for which the local override applies shall be adjustable from 5 to 480 minutes.
 - 9. Software shall include maintenance function to force all lighting zones to full-on.
 - 10. Control outdoor lighting fixture via relay control panels and input from exterior-mounted photocell.
 - 11. Upon loss of power system shall automatically restart and assume the default status for the programmed time of day. BACNet interface: Gateway available as an option. BACnet IP connection shall translate and forward discrete control commands from Port network to utilization devices.
 - 12. Furnish software licenses for all instances if installation (minimum of 6 copies). Include software upgrades for the duration of the warranty period.

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies. Comply with device manufacturer's recommendations for distance from HVAC equipment.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
- C. Photoelectric Cells shall be oriented north, and shall be directed to avoid detection of artificial light source.
- D. Installation shall comply with sensor manufacturer's recommendations.

3.2 CONTROL WIRING INSTALLATION

- A. CAT 5e data bus wiring shall comply with either of the following:
 - 1. Routed in raceway.
 - 2. Armored, plenum rated cables:
 - a. Route contiguously against the same raceway that supplies power to the lighting fixtures.
 - b. Attach to raceway with white nylon tie wraps that have a minimum tensile strength of 50lbs, secure by a tie wrap gun.
 - c. The interval between tie wraps shall not exceed 30 inches.
 - d. The unsupported flex distance from a raceway to a lighting control device shall not exceed 24 inches. Where circumstances necessitate longer distances provide intermediate rigid supports such as angle irons, channel or raceway.
 - e. Do not attach cables to systems other than lighting raceways (power raceways, communication cable trays, piping, etc.).
 - f. No more than three lighting control cables may be attached to a single raceway.
 - g. Where cables are routed to devices that do not require raceway connections, such as occupancy and photo sensors, route the cable contiguously against rigid angle iron, channel or an empty raceway that is dedicated to the lighting control system. Tie wrap at intervals not exceeding 30 inches.
- B. Bundle, train, and support wiring in enclosures.
- C. Ground equipment.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Do not splice CAT 5 wiring.

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- E. Connections: Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
- F. Use of WIFI during construction for aiming and zonal configuration is permitted. Post construction use of WIFI is not acceptable.

3.3 IDENTIFICATION

- A. Label lighting control panels with equipment designation, power source and circuit numbers, and power source location.
- B. Label all relays and control devices.
- C. Create a directory to indicate loads served by each relay; incorporate Owner's final room designations. Obtain approval before installing. Use a PC to create directory; handwritten directories are unacceptable. Submit directory in excel format to F&I upon project completion. Directory must accurately reflect as-built conditions. See F&I standard "260943A – LCP TEMPLATE" for sample directory template.

3.4 PROGRAMMING

- A. Engage Port personnel for programming of lighting control system in three four hour sessions. Establish operation scenarios for light fixture control according to time of day, sensor input, and local overrides. Determine naming of control zones according to area, gate or other parameters as directed by the Port.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Engage a factory-authorized service representative to test, adjust, and program programmable lighting control systems.
- B. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.
- C. Inspect control components for defects and physical damage, testing laboratory labeling, and nameplate compliance with the Contract Documents.
- D. Check tightness of electrical connections with torque wrench calibrated within previous six months. Use manufacturer's recommended torque values.
- E. Verify settings of photoelectric devices with photometer calibrated within previous six months.
- F. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following according to manufacturer's written instructions:

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1. Continuity tests of circuits.
 2. Operational Tests: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
 - a. Include testing of dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.
- G. Perform the following calibration, tests and inspections:
1. Occupancy Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
 - a. Visually check placement and aiming of sensors and LED activity.
 - b. Verify that wiring type, technique, connections, and polarity are correct.
 - c. Test sensor function:
 - 1) Motion
 - a) Set sensitivity to Minimum. Set time delay to Minimum. Verify OFF.
 - b) Adjust sensitivity to desired setting. Verify ON with motion.
 - c) Adjust time delay to desired setting. Walk-test room for sensitivity.
 2. Daylight Sensors
 - a. Visually check placement and aiming of sensors and LED display.
 - b. Verify that wiring type, technique, connections and polarity are correct.
 - c. All room finishes and furniture must be installed prior to start-up, calibration and testing. If a desk or table is within the area viewed by the photocell, then the desk should be unpacked and the surface cleaned prior to final calibration.
 - d. Any window treatment must be installed and operable prior to start-up. Blinds must be positioned as they would be under normal conditions.
 - e. Do not calibrate dimming controls under overcast skies. Controls adjusted under these conditions are likely to over-dim the lights under sunny conditions.
 - f. Calibrate and test sensor function:
 - 1) Adjust deadband and cutoff levels based on project requirements.
 - 2) Set light level to Minimum. Set sensitivity level to minimum. Set time delay to Minimum. Verify OFF.
 - 3) Adjust sensitivity to desired setting. Cover sensor lens. Verify ON.
 - 4) Adjust Light Level to desired setting.
 - 5) Adjust time delay to desired setting.
- H. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.
- I. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
- J. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.6 ADJUSTING

- A. Occupancy Adjustments: Provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide visits to Project between 1 and 4 AM as follows:
 - 1. Prior to first phased startup
 - 2. Two days after first occupied use of a phased construction space
 - 3. 30 days after occupied use of above phased construction space
 - 4. At each additional phase of occupancy
- B. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Port's operations.
- C. For daylighting controls, adjust set points and deadband controls to suit Port's operations.

3.7 CLEANING

- A. Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Port maintenance personnel as specified below:
 - 1. Train Port maintenance personnel on troubleshooting, servicing, adjusting, and maintaining equipment and schedules.
 - 2. Review data in maintenance manuals.
 - 3. Schedule training with the Port with at least seven days' advance notice.
 - 4. Provide three separate training sessions: Two at key intervals of phased construction, and one at completion of all work.

3.9 ON-SITE ASSISTANCE

- A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested, to adjust light levels, make preset scene changes, and adjust controls to suit actual conditions.
- B. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Port's operations.
- C. For daylighting controls, adjust set points and deadband controls to suit Port's operations.
- D. Provide complete and up-to-date documentation of all programmed settings at substantial completion.

F&I STANDARD