POWER DISTRIBUTION – OUTLET AND PIGTAIL BOXES

General

7. Connectors shall be available as 20A, 50A and 100A grounded stage pin, 20A twist lock and 20A “U” ground (dual rated “T-slot”); other connectors shall be available as specified.

8. Pigtails shall be three-wire type “SOW” rubber jacketed cable sized for the maximum circuit ampacity.

9. Pigtails with 20 amp stage pin connectors shall be terminated using 12 gauge 4 way indent crimp (with inspection window) type where the wire is inserted and crimped directly in the socket.

10. Terminations for pigtail connectors shall utilize feed- through terminals individually labeled with corresponding circuit numbers.
    a. 20 amp circuits shall use screwless tension clamp terminals listed for 20 – 8 gauge wire.
    b. 50 amp circuits shall use compression terminals listed for 10 – 1 gauge wire.
    c. 100 amp circuits shall use compression terminals listed for 8 – 2/0 gauge wire.
    d. Terminals that place a screw directly on the wire are not acceptable.

11. Outlet and pigtail boxes shall be supplied with appropriate brackets and hardware for mounting as shown on the drawings
    a. Standard mounting options shall include pipe or wall mounting
    b. Brackets shall be made from ASTM A 36 steel
    c. Hardware shall be ASTM A307 grade 5.

12. A low voltage distribution system shall be available to incorporate DMX, Ethernet or other protocols as specified in the power distribution box.
    a. A voltage barrier shall be used to separate the low voltage wiring for the electrical circuits.

13. Power distribution equipment shall be listed by a nationally recognized test lab (nrtl).

Physical

14. Outlet and pigtail boxes shall be 6.25” H x 3.3” D and fabricated from 18 gauge galvanized steel and finished in black fine-texture powder coat paint.
    a. Covers shall be fabricated from 16-gauge galvanized steel

15. Outlet and pigtail boxes shall be available in any length specified in increments of 3-inches with a maximum length of up to 3-feet.

16. Pigtails and outlets shall be spaced on 18” centers, or as otherwise specified.

17. Outlets shall be mounted on individual 3” panels.

18. Circuits shall be labeled with 1.25” lettering.

    a. Circuit labeling options shall include:

        1) Circuits shall be labeled on the front side of the connector strip with white lettering on black background labels.

        2) Circuits shall be labeled on front and back sides of the connector strip with white lettering on black background labels.

        3) Circuits shall be labeled on the front side of the connector strip with engraved lamicoid labels utilizing white lettering on black background labels.

        4) Circuits shall be labeled on the front and rear sides of the connector strip with engraved lamicoid labels utilizing white lettering on black background labels.

        5) Circuits shall be labeled on one side of the connector strip using individual circuit cover plates with lettering engraved in the cover and filled with the specified color.

        6) Circuits shall be labeled using specified labeling per plans and drawings

19. Outlet and pigtail boxes shall support optional LED indicators to indicate the presence of power at each local circuit. The indicator shall be red in color and mounted in outlet or pigtail box.

    a. The LED indicator shall be mounted in the lower right corner of the outlet panel

    b. The LED indicator shall be mounted in the bottom of the outlet or pigtail box directly below the outlet panel.

    c. The LED indicator shall be mounted in the cover plate directly below the circuit label for pigtail circuitS

UNISON ERN SERIES CONTROL ENCLOSURES

CONTROL ENCLOSURES

The control enclosure shall be the Unison ERn Series Control Enclosure as manufactured by Electronic Theatre Controls, Inc., or equal.

Mechanical

20. The External Processing enclosure shall be a surface mounted panel constructed of 18 gauge formed steel panels with a hinged, lockable full-height door containing an integral electrostatic air filter.

    a. The enclosure door shall have an opening to allow limited access to the control module face panel.

    b. Enclosures shall be convection cooled without the use of fans.

21. Control Enclosures shall be sized to accept one or two Control Processors and one or two Station Power Modules, including various options and accessories.

a. The Control Enclosure for a single control processor (ERn2) shall support a single Station Power Supply module; The Control Enclosure for 2 control processors (ERn4) shall support a quantity of 2 modules.

22. All enclosure components shall be properly treated and finished.

    a. Exterior surfaces shall be finished in fine textured, scratch resistant, powder based epoxy paint.

23. Enclosure(s) shall also be available in a 19” rack mounted (RM) version.

    a. Rack-mounted version shall have an independent enclosure suspension kit, with a full height, locking door/cover attached to the kit.

    b. Rack-mounted version shall have an opening to access the control module face panel, and openings to view indicators on option modules.

24. Enclosure dimensions and weights (without modules) shall not exceed:

    a. ERn2 - 15" W x 9" H, 10" D, 15 lb.

    b. ERn2-RM - 19" W 11"H 10" D, 20 lb.

    c. ERn4 - 15" W x 14" H x 10" D, 20 lb.

    d. ERn4-RM - 19" W x 16" H x 10" D, 25 lb.

25. Top, bottom, and side knockouts shall facilitate conduit entry.

26. Enclosures shall be designed to allow easy insertion and removal of all control and option modules without the use of tools.

    a. Supports shall be provided for precise alignment of modules into power and signal connector blocks.

    b. With modules removed, enclosures shall provide clear front access to all power and control wire terminations.

27. Option Modules

    a. Ethernet Switch

        1) The Control Enclosure shall support an optional 5-port Ethernet Switch, with at least 4 ports supplying Power over Ethernet (PoE).

        2) The Ethernet Switch module shall be 100BaseTX, auto MDI/MDIX, 802.3af PSE compliant.

        3) The Ethernet Switch module shall contain power, status, and activity indicators. All indicators shall be visible when the enclosure door is open for both rack and wall mounted ERn.

    b. Redundant Power Supply (RRPS)

        1) The Control Enclosure shall support an optional redundant power supply which shall automatically provide power to the control electronics upon failure or removal of the primary power supply.

        2) The redundant power supply shall assert itself seamlessly without a loss of power to the control electronics.

        3) The redundant power supply shall seamlessly remove itself when the primary power supply is reengaged.

4) The redundant power supply shall provide visible indication that it is active.

c. Station Bus Repeaters (ERn4 only)

1) The Control Enclosure shall support an optional module to expand the station bus length an additional 400 meters, and the station count an additional 30 stations (60 maximum per processor/enclosure)

2) Wall-mount and 19" Rack-Mount versions shall also be available to support mid-span insertion away from the Control Enclosure.

d. Station Bus Dual Repeaters (ERn4 only)

1) The Control Enclosure shall support an optional module to expand the station bus length to two additional 400 meter segments (a total of 1200 meters from a single enclosure, and the station count to 60 stations (60 maximum per processor/enclosure).

2) Wall-mount and 19" Rack-Mount versions shall also be available to support mid-span insertion away from the Control Enclosure.

28. Accessories

a. RideThru Option (RTO)

1) The Control Enclosure shall support an optional, short-term back-up power source for the control electronics.

2) RideThru Option (RTO) provides power for controls electronics during brief power outages or drop outs.

3) The short-term back-up power source shall automatically engage upon the loss of normal power, seamlessly transitioning the supply power for the control electronics power to itself.

4) The short-term back-up power supply shall detect the return of normal power, and seamlessly return the control electronics to normal power.

5) The short-term back-up power source shall support the control electronics for at least 10 seconds.

b. BatteryPack Option (BPO)

1) The Control Enclosure shall support an optional, long-term back-up power source for the control electronics.

2) The long-term back-up power source shall automatically engage upon the loss of normal power, seamlessly transitioning the supply power for the control electronics power to itself.

3) The long-term back-up power source shall supply power to the control electronics for at least 90 minutes.

4) The long-term back-up power supply shall detect the return of normal power, and seamlessly return the control electronics to normal power.

5) A test switch/indicator shall be available without opening the rack door or removal of any modules/components.

Electrical

29. External Processing enclosures shall be available in 100, 120, 230 and 240 volt, single-phase configurations.

30. External Processing enclosures shall be completely pre-wired by the manufacturer. The contractor shall provide input and control wiring.

31. External Processing enclosures shall be designed to support the following wire terminations:

    a. AC (single phase)

    b. Echelon link power (Belden 8471 or equivalent)

    c. 24Vdc (2- 16AWG Wire)

    d. DMX512A Port A (In or Out) (Belden 9729 or equivalent)

    e. DMX512A Port B (In or Out) (Belden 9729 or equivalent)

    f. RS232 Serial In/Out (Belden 9729 or equivalent)

    g. Unshielded Twisted Pair (UTP) Category 5 Ethernet

    h. Contact Closure In (14AWG to 26AWG Wire)

    i. Contact Closure Out (14AWG to 26AWG Wire)

        1) Contact Closure Out shall provide 1A @ 30vDC

32. Station Power Modules

    a. Station power supply modules shall provide LinkPower for at 32 stations and 1.5A@24VDC of Auxiliary (AUX) power.

    b. Station power repeater modules shall provide LinkPower for 30 stations and1.5A@24VDC of Auxiliary (AUX) power.

    c. Station power module shall support over-current/short protection for LinkPower and Aux. LinkPower shall support fault detection on each leg of the balanced data bus.

33. All control wire connections shall be terminated via factory provided connectors.

Thermal

34. Ambient room temperature: 0-40°C / 32-104°F

35. Ambient humidity: 10-90% non-condensing

ARCHITECTURAL CONTROL PROCESSOR MODULES

CONTROL PROCESSOR MODULES

The Architectural Control Processor shall be the Unison Paradigm Series, P-ACP Control Processor as manufactured by Electronic Theatre Controls, Inc., or equal.

Mechanical

36. The Architectural Control Processor (ACP) assembly shall be designed for use in DRd Series Power Enclosures and ERn Series Control Enclosures.

37. The processor shall utilize microprocessor based, solid state technology to provide multi-scene lighting and building control.

38. ACP module electronics shall be contained in a plug-in assembly.
    a. The module shall be housed in a formed steel body and contain no discrete wire connections.
        1) No tools shall be required for module removal or insertion.

39. The ACP shall be convection cooled.

40. User Interface
    a. The ACP shall utilize a backlit liquid crystal display capable of graphics and eight lines of text.
    b. The ACP shall provide an alpha-numeric keypad for data entry and navigation.
    c. The ACP shall provide a touch-sensitive control wheel for navigation.
    d. The ACP shall provide shortcut buttons to assist in navigation, selection, and data entry.
    e. The ACP keypad, buttons, and wheel shall be backlit for use in low-light conditions.
        1) The backlight shall have a user selectable time out, including no time out.

41. The ACP shall provide a front-panel RJ45 receptacle for Ethernet connection to the processor for configuration, live control, and web-browser-based system access.
    a. The RJ-45 receptacle shall be secured behind the locking door.

42. The ACP shall provide a Secure Digital (SD) Removable Media slot on the front panel for transfer of configuration data.
    a. The SD slot shall be secured behind the locking door.

43. The ACP shall provide a Universal Serial Bus (USB) port on the front panel for transfer of configuration data.
    a. The USB port shall be secured behind the locking door.

44. Architectural Lighting System configuration and program information shall be stored in flash memory, which does not require battery backup.
    a. The ACP shall provide a Compact Flash (CF) Card as backup flash memory and storage.
    b. The CF Card is located in the back of the ACP and can be accessed only by removing the ACP.
    c. The ACP data can be exchanged by inserting the CF card into another ACP.

Electrical

45. The ACP shall require no discrete wiring connections; all wiring shall be terminated into Dimming or Control Enclosure.

46. The ACP shall require low-voltage power supplied by the Dimming or Control enclosure.

47. The ACP shall be hot-swap capable.

48. The ACP shall support Echelon LonTalk with LinkPower communications with control stations and other remote devices, including button stations, button/fader stations, Touchscreen stations, sensors, and third party LonMARK compliant products.

    a. The LinkPower network shall utilize polarity-independent, low-voltage Class II twisted pair wiring, type Belden 8471 (unshielded) or Belden 8719 (shielded) or equivalent. One # 14 AWG drain wire will be required for system not using grounded metal conduit. Touchscreen stations, interface stations and portable stations connectors will also require (2) #16 AWG wires.

    b. The LinkPower network shall be topology free. Network wiring may be bus, loop, home run, star or any combination of these.

    c. Link power wiring shall permit a total wire run of 1640 ft. (500m) without a repeater. Repeater option modules shall be available to increase wiring maximums in increments of 1640 ft. (500m).

    d. Link power wiring between stations shall not exceed 1313 ft. (400m).

49. The ACP shall support 10/100BaseTX, auto MDI/MDIX, 802.3af compliant Ethernet networking using TCP/IP, ESTA BSR E1.17 Advanced Control Networks (ACN) and ESTA BSR E1.31 (sACN) Protocols for internal communication and integration with third-party equipment.

50. The ACP shall support EIA-RS232 serial protocol for bi-directional command and communication with third-party equipment.

51. The ACP shall support two discrete ESTA DMX512A ports, configurable as input or output ports.*

    a. *When used in a Dimming Enclosure, the second port is always an output port.

52. The ACP shall provide four onboard dry contact closure inputs for integration with third-party products.

53. The ACP shall provide four onboard contact closure outputs, rated at 1A@30VDC, for integration with third-party equipment.

Functional

54. Capacity

    a. Shall support 1024 channels of control

b. Shall support 2 physical DMX ports, each of which may be configured as an input or output

55. System

a. Runtime application shall utilize support Net3 system interoperability

b. System shall support the use of Network Time Protocol for real time clock synchronization

c. System shall support remote firmware upload an over Ethernet connection from a connected PC running the Light Designer software or another connected processor.

d. System shall support local firmware upload from removable media (SD Card, USB Flash Drive)

56. Diagnostics

a. Shall output an Event log

b. Standard log shall store a fixed-length history of recent activity

c. Separate critical log shall only store important messages (such as boot-up settings)

57. Configuration Data

a. Configuration Data can be uploaded over an Ethernet connection from a PC running Light Designer application

b. Configuration Data can be retrieved from another Paradigm Processor

c. A Paradigm Processor shall make its configuration data available for retrieval by another Processor as a backup/recovery mechanism

d. Configuration Data shall be stored on solid-state media that can be removed to facilitate transfer between Processor units

e. Configuration Data may be loaded to and from removable media access provided on front panel

f. Configuration Data for the entire System shall be available for download from any single Processor

g. Shall store configuration data for Dimming enclosure processors and shall make available for download

58. Scalability

a. Adding additional Processors to a System shall proportionately increase its overall capabilities up to a maximum project size

b. The maximum number of Processors configured as a project shall be at least 12. The use of a Central Control Processor (P-CCS) shall allow for larger system sizes up to 72 processors

c. Multiple Processors shall utilize the Ethernet network to remain time synchronized and share control information

d. Multiple Processors shall utilize the Ethernet network to maintain configuration data synchronization as modifications are made

e. Failure of a single Processor shall not prohibit continuing operation of the remaining Processors

f. It shall be possible for multiple Systems to coexist on the same physical network with logical isolation between Systems

59. Local User Interface

a. Shall provide access to Processor setup (IP address)

b. Shall provide access to Processor status and diagnostics

c. Where the Processor is installed within a Dimming enclosure, shall provide access to Dimming enclosure setup, status and diagnostics

d. Shall provide control functionality for Control Channels, Zones, Fixtures, Groups, Presets, Macros, Walls and Sequences within the current configuration.

e. Shall provide functionality to schedule astronomical and real time events (add/edit/delete)

f. Shall allow for display of local DMX information

g. Shall allow for transfer of log files to local removable media

h. Shall allow to perform firmware upgrades for connected Dimming enclosures

i. Shall allow for transfer of configuration to and from Dimming enclosures using removable media

j. Shall allow for transfer of configuration to and from LCD Stations using removable media

k. Shall allow for binding of Stations

60. Access Controls

a. There shall be 2 user accounts - Administrator, and User with separate password protection

b. Account and password settings shall be local to each Processor

c. Access Controls shall be applied to certain areas of the Paradigm Local User Interface and Web Interface

61. Web User Interface

a. Shall be an internal web server accessible via Ethernet port

b. Shall support common web browsers on Windows and Mac platforms

c. Shall provide functionality to Activate and Deactivate Presets

d. Shall provide functionality to schedule timed events (add/delete)

e. Shall display status information

f. Shall display log files

g. Shall allow for configuration of Processor settings (date, time)

h. Shall allow for upload and download of configuration data

i. There shall be links to other web-enabled devices in the System, including other Paradigm Processors

62. Stations

a. Stations shall be connected to a Paradigm Processor via a LinkPower network or Ethernet

b. Station discovery and binding shall be accomplished from the Local User Interface or Light Designer

63. Net3 and ACN Devices

a. Paradigm Processors shall provide DMX-Net3 gateway functionality

b. Net3 devices shall be connected to and controlled from the Processor via Ethernet

c. It shall be possible to send and receive Macro triggers defined within the System configuration via Net3

d. There shall be support for a maximum of 1024 Streaming ACN outputs configured to a maximum of 12 universes per Processor

64. Operation

a. When contained in an dimming enclosure, a snapshot of the dimming enclosure output data shall be stored in persistent memory so that hardware can access it for immediate output on boot

b. DMX output refresh rate shall be configurable

c. There shall be support for 16-bit DMX Attributes

d. DMX inputs may be patched to DMX and Streaming ACN outputs as external sources

e. Streaming ACN inputs shall be patched to DMX outputs (gateway) as external sources

f. Where there are multiple external sources then priority and HTP shall be used to perform arbitration

g. External and internal sources shall be arbitrated based on user-selection of standard or custom rules

h. On Preset Record, the values of Attributes within the Preset shall be updated to reflect the current output

i. The total output may be the combination of many different Presets running concurrently

j. There shall be no hard limit on number of concurrent cross fades

k. Multiple Presets controlling the same Attribute shall first interact based on priority and second based on Latest Takes Precedence (LTP) or Highest Takes Precedence (HTP)

l. LTP and HTP operation shall be supported simultaneously and interact (at the same priority) using HTP

m. Settings due to LTP Presets may be automatically discarded from operation when overridden

n. It shall be possible to specify that a Preset or Attribute Control will persist when overridden

o. A Preset may be designated as an HTP Override and shall cause HTP values to be discarded

p. It shall be possible to modify the rate of a Preset (Cross fades, Effects) from a Control within the System

q. Each Preset shall have a status that can be Activated, Deactivated or Altered

r. Preset status may be set based on matching levels in the current output as an option

s. On startup the System shall be capable of automatically executing timed events within the previous 24 hours to synchronize its initial output state with the current time of day

65. Serial Input/Output

a. RS232 shall support 8-bit word length, parity selection and 1 or 2 stop bits

b. RS232 shall support baud rates from 4800 to 115,200 bps

c. Serial input and output messages are fully customizable

d. Serial output messages can be generated by any Control or Event

STATION POWER MODULES

STATION PROCESSOR MODULES

The Station Power Module shall be the Unison Paradigm P-SPM Series Station Power Module as manufactured by Electronic Theatre Controls, Inc., or equal.

Mechanical

66. The Station Power Module (SPM) assembly shall be designed for use in DRd Series or ERn Rack Enclosures.

67. The SPM shall convert input power into low-voltage (Class II) power with data line and a secondary auxiliary low-voltage line to energize button, button/fader, touchscreen, and interface devices for multi-scene lighting and building control.

68. SPM module shall be contained in a plug-in assembly.

a. The module shall be housed in a formed steel body and contain no discrete wire connections.

1) No tools shall be required for module removal or insertion.

69. The SPM shall be convection cooled.

70. User Interface

a. The SPM shall utilize light emitting diodes (LED's) to indication function, status and fault.

71. The SPM shall be secured behind the locking door.

72. Wall-mounted, direct wire and 19” rack-mount, connectorized repeater and dual-repeater variants shall be available from the same manufacturer where required on the project.

Electrical

73. The SPM shall require no discrete wiring connections; all wiring shall be terminated into the dimming enclosure, unless required by a variant.

74. The SPM shall require line-voltage power supplied by the contractor, terminated inside the dimming or control enclosure.

75. The SPM shall be hot-swap capable.

76. The SPM, in conjunction with a matching Architectural Control Processor (ACP), shall support Echelon LinkPower communications with remote devices, including button, button/fader, touchscreen and interface stations, and shall interoperate with LonMARK-approved third-party devices.

    a. The LinkPower network shall utilize polarity-independent, low-voltage Class II twisted pair wiring, type Belden 8471 (unshielded) or Belden 8719 (shielded) or equivalent. One # 14 AWG drain wire will be required for system not using grounded metal conduit.

    b. The LinkPower network shall be topology free. Network wiring may be bus, loop, home run, star or any combination of these.

    c. Link power wiring shall permit a total wire run of 1640 ft. (500m)

        1) Repeaters allow an additional wire run of 1640 ft. (500m)

        2) Dual-repeaters allow two additional wire runs of 1640 ft. (500m)

    d. Link power wiring between stations shall not exceed 1313 ft. (400m).

77. The SPM shall support auxiliary power for certain remote devices, including touchscreen and interface stations, as required by the device.

    a. The auxiliary power network shall utilize polarity-dependent, low-voltage Class II wiring, consisting of two # 16 AWG wires.

    b. Auxiliary wiring shall permit a total wire run of 1640 ft. (500m)

        1) Repeaters allow an additional wire run of 1640 ft. (500m)

        2) Dual-repeaters allow two additional wire runs of 1640 ft. (500m)

    c. The SPM shall supply 1.25 amps at 24v DC continuously.

Functional

78. Capacity

    a. Each SPM shall:

        1) Supply power for up to 32 button and button/fader stations.

            a) Repeaters and dual-repeaters allow 30 additional stations, 62 total

        2) Supply auxiliary power for a similar number of interface stations.

3) Shall supply auxiliary power for up to four Touchscreen stations, when a like number of other stations are deducted from the total.

a) Repeaters and dual-repeaters allow two additional Touchscreens (six total) when a like number of other stations are deducted from the total.

79. Operation

a. The SPM shall not require configuration or programming.

b. The SPM shall automatically detect faults in the wiring, indicate the fault, including the fault polarity, and shut down the output power.

1) The SPM shall automatically reset when the fault is clear, and can be manually reset by removing and re-inserting the module.

BUTTON AND FADER STATIONS

STATIONS

Button Stations

80. The Lighting Control Stations shall be the Unison Heritage UH Series Control Stations as manufactured by Electronic Theatre Controls, Inc., or equal.

81. Mechanical

a. Unison Heritage Button stations shall operate using up to ten programmable buttons.

b. All button stations shall be available with white, cream, ivory, gray or black faceplates, and buttons.

1) Manufacturer's standard colors shall conform to the RAL CLASSIC Standard.

c. Stations shall have indicator lights at each button or fader.

1) Indicators shall be comprised of red, green and blue LED's

2) Indicator color and state (steady On, Blink, Off) shall be configured in software, and shall operate relative to the button or fader it is associated with.

d. All faceplates shall be designed for flush or surface mounting.

e. Station faceplates shall be constructed of ABS plastic and shall use no visible means of attachment.

f. Station faceplates shall be indelibly marked for each button or fader function.

g. The manufacturer shall supply back boxes for flush mounted half gang stations and for all surface mounted stations.

h. All Button stations shall be designed to accept the infrared signal from a remote hand held IR transmitter.

1) The stations shall have a 60° reception angle and shall operate reliably within a 45' distance.

i. IR Transmitters shall be available in five or ten button configurations.

1) IR transmitters shall be mounted in a hand-held black plastic controller.

2) Transmitter dimensions shall be 1.875” wide, 6.625” long and 0.60” deep.

82. Electrical

a. Unison control station wiring shall be an Echelon® Link power network.

1) Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit).

2) Network wiring may be bus, loop, home run, star or any combination of these.

3) Wiring termination connectors shall be provided with all stations.

b. Button Stations shall offer the following Regular markings

1) UL and cUL LISTED

2) CE Market

3) RHoS and WEE Compliant

83. Functional

a. The Unison Paradigm Control System shall be designed to allow control of lighting and associated systems via Button, Button/Fader, and Interface or Astronomical time clock controls. System shall allow the programming of presets, sequences, macros and time clock events.

1) System presets shall be programmable via Button stations, Touchscreen stations, and LightDesigner software.

a) Presets shall have a discrete fade time, programmable from zero to 1,000 hours with a resolution of one millisecond.

b) Presets shall be selectable via button, fader, IR transmitter, time clock event, macro activation or switch interface stations.

2) System macros and sequences shall be programmable via LightDesigner system software.

a) Macro and sequence steps shall provide user selectable steps and allow the application of conditional logic.

b) Macro and sequences shall be activated by button, time clock event or LightDesigner software.

3) System time clock events shall be programmable via LightDesigner system software, the processor user interface, or the internal web server.

a) Time clock events shall be assigned to system day types. Standard day types include: anyway, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.

b) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight saving time.

b. Control components shall be designed to operate default or custom system functions. Components shall operate default functions unless re-assigned via LightDesigner, the software-based configuration program.

1) Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, or room join/separate.

2) Optional fader functions include manual master control, individual zone control, fade rate control or preset master control.

c. Stations (Button and Button/Fader) shall allow programming of station and component electronic lockout levels via LightDesigner.

Fader Stations

84. The Lighting Control Stations shall be the Unison Heritage UH Series Control Stations as manufactured by Electronic Theatre Controls, Inc., or equal.

85. Mechanical

a. Unison Heritage Fader Stations shall operate using up to sixteen programmable faders and twelve programmable buttons.

b. All fader stations shall be available with white, cream, ivory, gray or black faceplates, fader knobs, and buttons.

1) Manufacturer's standard colors shall conform to the RAL CLASSIC Standard.

c. Fader stations shall utilize standard 45-millimeter slide potentiometers.

d. Stations shall have indicators lights at each button or fader.

1) Indicators shall be comprised of red, green and blue LED's

2) Indicator color and state (steady On, Blink, Off) shall be configured in software, and shall operate relative to the button or fader it is associated with.

e. All faceplates shall be designed for flush or surface mounting.

f. Station faceplates shall be constructed of ABS plastic and shall use no visible means of attachment.

g. Station faceplates shall be indelibly marked for each button or fader function.

h. The manufacturer shall supply back boxes for flush mounted half gang stations and for all surface mounted stations.

i. Fader stations shall be designed to accept the infrared signal from a remote hand held IR transmitter.

1) The stations shall have a 60° reception angle and shall operate reliably within a 45' distance.

j. IR Transmitters shall be available in five or ten button configurations.

1) IR transmitters shall be mounted in a hand-held black plastic controller.

2) Transmitter dimensions shall be 1.875” wide, 6.625” long and 0.60” deep.

86. Electrical

a. Unison control station wiring shall be an Echelon® Link power network.

1) Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit).

2) Touchscreen and Interface stations shall also require (2) #16 AWG stranded wires for 24Vdc operating power. 24Vdc wiring shall be topology free.

3) Network wiring may be bus, loop, home run, star or any combination of these.

4) Wiring termination connectors shall be provided with all stations.

b. Fader Stations shall offer the following Regular markings

1) UL and cUL LISTED

2) CE Market

3) RHoS and WEE Compliant

87. Functional

a. The Unison Paradigm Control System shall be designed to allow control of lighting and associated systems via Button, Button/Fader, and Interface, or Astronomical time clock controls. System shall allow the programming of presets, sequences, macros and time clock events.

1) System presets shall be programmable via Button, Button/Fader, Touchscreen, or LightDesigner software.

a) Presets shall have a discrete fade time, programmable from zero to 1,000 hours with a resolution of one millisecond.

b) Presets shall be selectable via button, fader, IR transmitter, time clock event, macro activation or switch interface stations.

2) System macros and sequences shall be programmable via LightDesigner system software.

a) Macro and sequence steps shall provide user selectable steps and allow the application of conditional logic.

b) Macro and sequences shall be activated by button, time clock event or LightDesigner software.

3) System time clock events shall be programmable via LightDesigner system software, the processor user interface, or the internal web server.

a) Time clock events shall be assigned to system day types. Standard day types include: anyway, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.

b) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight saving time.

b. Control components shall be designed to operate default or custom system functions. Components shall operate default functions unless re-assigned via LightDesigner, the software-based configuration program.

1) Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, or room join/separate.

2) Optional fader functions include manual master control, individual zone control, fade rate control or preset master control.

c. Stations (Button and Button/Fader) shall allow programming of station and component electronic lockout levels via LightDesigner.

Portable Plug-in Stations

88. The Lighting Control Stations shall be the Unison Heritage UH Series Control Stations as manufactured by Electronic Theatre Controls, Inc., or equal.

89. Mechanical

a. Unison connector stations shall provide an interface to portable Unison stations.

b. All connector stations shall be available with white, cream, ivory, gray or black faceplates.

1) Manufacturer's standard colors shall conform to the RAL CLASSIC Standard.

c. All faceplates shall be designed for flush or surface mounting.

d. Station faceplates shall be constructed of ABS plastic and shall use no visible means of attachment.

e. Station faceplates shall be indelibly marked with station function.

f. The manufacturer shall supply back boxes for all surface mounted stations.

90. Electrical

a. Unison control station wiring shall be an Echelon® Link power network.

1) Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit).

2) Portable plug-in stations shall also require (2) #16 AWG stranded wires for 24Vdc operating power. 24Vdc wiring shall be topology free.

3) Network wiring may be bus, loop, home run, star or any combination of these.

4) Wiring termination connectors shall be provided with all stations.

b. Portable Plug-in Stations shall offer the following Regular markings

1) UL and cUL LISTED

2) CE Market

3) RHoS and WEE Compliant

91. Functional

a. The Unison Paradigm Control System shall be designed to allow control of lighting and associated systems via Button, Button/Fader, and Interface or Astronomical time clock controls. System shall allow the programming of presets, sequences, macros and time clock events.

1) System presets shall be programmable via Button, Button/Fader, Touchscreen, or LightDesigner software.

a) Presets shall have a discrete fade time, programmable from zero to 1,000 hours with a resolution of one millisecond.

b) Presets shall be selectable via button, fader, IR transmitter, time clock event, macro activation or switch interface stations.

2) System macros and sequences shall be programmable via LightDesigner system software.

a) Macro and sequence steps shall provide user selectable steps and allow the application of conditional logic.

b) Macro and sequences shall be activated by button, time clock event or LightDesigner software.

3) System time clock events shall be programmable via LightDesigner system software, the processor user interface, or the internal web server.

a) Time clock events shall be assigned to system day types. Standard day types include: anyway, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.

b) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight saving time.

b. Control components shall be designed to operate default or custom system functions. Components shall operate default functions unless re-assigned via LightDesigner, the software-based configuration program.

1) Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, or room join/separate.

2) Optional fader functions include manual master control, individual zone control, fade rate control or preset master control.

Locking Covers

92. The Lighting Control Station Locking Covers shall be the Unison Heritage UH Series as manufactured by Electronic Theatre Controls, Inc., or equal.

93. Mechanical

a. Locking covers shall be available in Sliding Locking for flush mount applications and Hinged Locking for flush and surface mount applications

b. Sliding Locking Covers shall:

1) Be available with white, cream, ivory, gray or black faceplates.

2) Be constructed of Extruded Aluminum with ABS plastic end caps

3) Provide a smoked Plexiglas window to allow for viewing control status and use of IR remote without opening cover

c. Hinged locking covers shall:

1) Be available in standard black powder coat finish

2) Be constructed of 18 gauge steel and finished in standard black powder coat paint, or custom color as specified.

3) Provide a clear Plexiglas window to allow for viewing control status and use of IR remote without opening cover

4) Use internal Hinge that is not accessible when the cover is closed

d. Standard colors shall conform to the RAL CLASSIC Standard.

e. Locking covers of the same type shall be keyed alike

f. The manufacturer shall supply back boxes for all hinged locking covers.

94. Functional

a. All locking covers shall utilize 90-degree locking mechanisms

1) Keys shall be held captive in locks when covers are unlocked.

b. Locking covers shall allow for easy viewing of system status without opening the cover

c. Locking covers shall support IR remote activation of configured system functions without opening door

DATA PLUG-IN STATIONS

General

95. The Plug-in Stations shall consist of the appropriate connectors required for the functional intent of the system. These stations shall be available with DMX input or output, Remote Focus Unit, Network, or architectural control connectors. Custom control connectors shall be available.

Connector Options

96. The following standard components shall be available for Plug-in Stations:

a. 5-Pin male XLR connectors for DMX input

b. 5-Pin female XLR connectors for DMX output

c. 6-Pin female XLR connectors for RFU and ETCLink connections

d. RJ45 connectors for Network connections - Twisted Pair

e. 6-Pin female DIN connectors for Unison connections

f. DB9 female serial connector for architectural control from a computer

97. Custom combinations and custom control connections shall be available.

Physical

98. Station faceplates shall be .80” aluminum, finished in fine texture, scratch-resistant black powder coat. Silk-screened graphics shall be white.

99. The station panel shall mount into an industry standard back box, depending on size and quantity of connectors. A terminal block shall be supplied for contractor terminations.

OCCUPANCY AND VACANCY SENSORS

RESPONSIVE CONTROLS

Ceiling Mount Occupancy/ Vacancy Sensors

100. The Lighting Occupancy and Vacancy Sensors shall be the Unison Paradigm Responsive Controls Series as manufactured by Electronic Theatre Controls, Inc., or equal.

101. Mechanical

a. All sensors shall be constructed of ABS plastic and available in pure white or black
   1) Manufacturer's standard colors shall conform to the RAL CLASSIC Standard.

b. Sensors shall provide configuration buttons for:
   1) Linking of station to lighting control system
   2) Enabling walk-test mode

c. Sensors shall include customizable masks to block unwanted areas from view
   1) Masks shall be field installable without the need to unmount or disassemble the sensors

d. Sensors shall have no visible means of attachment

e. Sensors shall include an adjustable mounting base that supports the following mounting options:
   1) Mounting to any standard ceiling box
   2) Mounting to any standard junction box
   3) Mounting to single gang RACO box
   4) Mounting to drywall or soft ceiling tiles using an included wire form adapter

f. Sensors shall include necessary mounting screws and hardware

g. Sensors shall include all necessary mounting hardware, wiring connectors, and instructions.

h. Sensors shall utilize multi-segment lens with internal slots to reduce buildup of dust.

i. Sensors shall be available with three coverage options for:
   1) Large room: 1800 sq. ft. at 8’ ceiling, 3000 sq. ft. at 12’ ceiling

2) Small room: 450 sq. ft. at 8’ ceiling, 800 sq. ft. at 12’ ceiling

3) High Ceiling: 350 sq. ft. at 10’ ceiling, 7000 sq. ft. at 40’ ceiling

102. Electrical

a. Sensor wiring shall be low-voltage Class 2 wiring

b. Sensors shall use Unison LinkConnect control wiring

1) Wiring shall be an Echelon® Link power network.

2) Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit).

3) Network wiring may be bus, loop, home run, star or any combination of these.

4) Network termination connectors shall be provided with all sensors

c. Sensors shall be designed and tested to withstand discharges without impairment of performance when subjected to discharges of 15,000 volts per IEC 801-2.

d. Sensors shall utilize LED illumination for status feedback of motion detection and for use during programming

e. Sensors shall be UL and cUL LISTED and CE marked

103. Functional

a. The Control System shall support sensors for occupancy or vacancy detention

1) A single sensor shall support occupancy or vacancy detection based on software configuration

b. Sensors shall meet ASHRE 90.1, CA Title 24 and NYC local law 48

c. Provide 360-degree coverage range and include configurable masking.

d. Sensors functions shall be programed using LightDesigner configuration software

1) Shall support configurable time delay and sensitivity

2) Shall support independent programming of any system function as occupied and unoccupied events

3) Shall support overrides

e. Sensors shall support walk-thru mode for simple testing of coverage

1) Illumination of sensor lens shall be used to indicate movement is detected, even with lens masks are installed.

2) Activation shall not require special tools or software

3) Provides 5 minute timeout to return to normal operation

DMX DISTRIBUTION

General

104. The Pathway Installation Repeater shall permit star-wiring of DMX512 signals and shall isolate DMX transmitters and DMX receivers from common mode voltages, ground loop currents and other electrical faults.

105. Each Installation Repeater shall have one input port and four, eight, twelve or sixteen output ports. No in-line processing of the input signal is permitted to ensure the highest reliability.

106. DMX signal splitting shall be provided using 4-output DIN-rail mounted modules for easy expansion and/or servicing.

107. The system shall be capable of repeating simplex protocols other than DMX512, provided they meet the electrical requirements of EIA-RS422 or RS485.

Physical

108. Enclosures shall be surface-mount NEMA 1 enclosure types, and shall be constructed from 18 gauge steel, finished in satin black powder epoxy, with a non-louvered, surface cover.

109. Dimensions shall be 10.25”w x 13.25”h x 4.5”d (260mm x 335mm x 120mm) for four or eight output models, and shall be 10.25”w x 23.25”h x 4.5”d (260mm x 510mm x 120mm) for twelve or sixteen output models.

110. Enclosures shall be provided with ½” and ¾”conduit knockouts, appropriate internal voltage barriers, and shall be clearly labeled as “Pathway eDIN System”.

Electrical

111. The power supply shall be a field-replaceable, wide-range input (115/240VAC, 50/60 Hz), UL-listed switching power supply. There shall be no power switch to reduce the chance of accidental shut-off.

112. There shall be 2500-volt electrical isolation between all input and output sections.

113. The input and each output shall be capable of withstanding the continuous application of up to 250V without damage to internal components. Input and output protection shall be of the self-resetting type, rated for 250V. Replaceable fuses are not acceptable.

Field Connections

114. All internal field wiring connections shall be clearly labeled according to their function.

115. Connections for all data input, output and pass-thru ports, and DC power shall be two-part, Phoenix-type screw terminal strips, capable of accepting #26 to #14 gauge solid or stranded wire.

116. A direct, passive data pass-thru connection shall be provided to allow daisy-chaining of additional modules or Installation Repeaters.

117. The power supply connections shall be capable of accepting up to #12 gauge solid or stranded wire. A suitable terminal shall be provided for ground wire connection.

Features

118. Each repeater module shall incorporate LED indicators for DC power input, isolated DC power, and DMX input.

119. An LED per output port shall indicate active DMX output for that port.

120. A labeled DMX termination switch shall be provided. DIP switches or the like shall not be acceptable.

Compliance

121. The Installation Repeater shall be compliant with ANSI E1.11 DMX512-A (2004), USITT DMX512 (1990) or any EIA 422/485-based protocol.

122. The Installation Repeater shall be ETL-listed.

123. The Installation Repeater shall be compliant with the RoHS 2002/95/EC directive.

Acceptable Product

124. Supply Pathway Installation Repeaters only.

125. This specification applies to Pathway model #4807, 4808, 4809, and 4810 only.

PART 3 LIGHTING FIXTURES

ELLIPSOIDAL SPOTLIGHTS

General

1. The instrument shall be a Source Four ellipsoidal spotlight as manufactured by Electronic Theatre Controls, Inc., or approved equal. Used or New condition acceptable

Physical

2. The unit shall be constructed of rugged, die cast aluminum, free of burrs and pits, finished in black, high temperature epoxy paint. Tools shall not be required for either lamp alignment or cleaning the reflector or lens

3. The following shall be provided:
   a. Integral cable clamp for power leads
   b. Positive locking of lamp focus and independent lamp alignment controls
   c. High impact, thermally insulated knobs and shutter handles
   d. Reflector secured with shock mounts
   e. Lens secured with silicone shock mounts
   f. Shutter assembly shall allow for +/-25° rotation
   g. 20 gauge stainless steel shutters

h. Insulated rear handle

i. Interchangeable lens tubes for different field angles with Teflon guides for smooth tube movement

j. Sturdy integral die cast gel frame holders with two accessory slots, and a top mounted, quick release gel frame retainer

k. Rugged 3/16” x 1-1/4” steel yoke with two mounting positions allowing 300°+ rotation of the fixture within the yoke

l. Positive locking, hand operated yoke clutch

m. Slot with sliding cover for motorized pattern devices or optional iris

Optical

4. The optical train shall combine a compact filament lamp with a precision molded borosilicate, ellipsoidal reflector and aspheric lens to produce an optimum cosine field.

5. The unit shall provide, but not be limited to:

   a. Molded borosilicate reflector with multiple dichroic layers

   b. 95% of visible light shall be reflected while 90% of infrared light as heat shall be transmitted through the reflector

   c. Low gate and beam temperature

   d. Sharp imaging through a three plane shutter design

   e. Projector-quality, high contrast aspheric lens, with an anti-reflective coating to increase transmission

Performance

6. The unit shall be precision engineered to use an HPL lamp to deliver an even, intense field with cosine distribution.

7. The unit shall provide, but not be limited to:

   a. 5, 10, 14, 19, 26, 36, 50, 70 and 90 degree field angles

   b. High-quality pattern imaging

   c. Sharp shutter cuts without halation

   d. Shutter warping and burnout in normal use shall be unacceptable

   e. Adjustable hard and soft beam edges

8. The unit shall be capable of utilizing ETC Dimmer Doubling technology

9. The unit shall be UL and cUL listed and so labeled.

10. 19, 26, 36, and 50 degree units shall have optional lens tubes available for precision, high-contrast imaging.

Lamp

11. The high efficiency lamp shall be an HPL lamp, which shall consist of a compact tungsten filament contained in a krypton-filled quartz envelope. The lamp shall mount axially within the reflector. The lamp base shall have an integral die cast aluminum heat sink that reduces seal temperature and ensures proper lamp alignment. The lamp socket shall be ATP 220 nickel gold plated.

FOLLOWSPOT

A. THE BASIS OF THIS DESIGN SHALL BE THE 1266 SUPER ARC 400 FOLLOW SPOTLIGHT, AS MANUFACTURED BY LYCIAN STAGE LIGHTING OF SUGAR LOAF, NY.

B. PHYSICAL

1. THE UNIT FRAME AND ENCLOSURE SHALL BE CONSTRUCTED OF FORMED COLD ROLLED STEEL AND STURDY ALUMINUM CASTINGS, FREE OF BURRS AND PROTECTED BY A GRAY AND BLACK POWDER COAT FINISH.

A. THE LAMPHOUSE SHALL INCLUDE VENTING TO DIRECT HEAT OUT F THE FOLLOWSPOT LAMPHOUSE.

B. HANDLES SHALL BE PROVIDED TO FACILITATE SMOOTH OPERATION AND TO LIFT THE UNIT.

2. THE UNIT SHALL BE MOUNTED ON A STABLE, FOLDING THREE-POINT STAND WITH LOCKING CASTERS AND LEVELING JACKS.

3. THE POWER SUPPLY SHALL BE INTEGRATED IN THE FOLLOWSPOT.

4. WEIGHT OF THE FOLLOWSPOT HEAD AND BASE SHALL NOT EXCEED 134 POUNDS.

5. LENGTH OF HEAD UNIT WITH COLOR CHANGING BOOMERANG SHALL NOT EXCEED 32 1/2."

C. CONTROLS

1. THE UNIT SHALL, AS A MINIMUM INCORPORATE THE FOLLOWING:

A. BULB OPERATION ELAPSED HOUR METER

B. FORCED-AIR COOLING BY INTERNALLY WIRED BLOWERS AND A FAN

C. ON/OFF IGNITION CONTROL (ROCKER SWITCH LOCATED ON BODY)

D. THE LUMINAIRE SHALL INCORPORATE AN EXTERNALLY OPERABLE, CONTINUOUSLY VARIABLE CALIBRATEDPEAK/FLAT FIELD ADJUSTMENT. THE FIELD DIAMETER OF THE BEAM SHALL BE CONTINUOUSLY VARIABLE FROM THE NARROWEST HEAD SPOT TO THE WIDEST FLOOD BY MEANS OF A NICHROME STEEL IRIS WHICH SHALL BE OPERABLE BY AN EXTERNAL INSULATED, OFFSET LEVER. UNITS THAT IRIS DOWN WITHOUT INCREASE OF LIGHT OUTPUT SHALL NOT BE ACCEPTABLE.

E. HTI BULB MOUNT, ALLOWING UNIT TO BE SAFELY WHEELED WITH BULB IN PLACE

F. MOUNTED SAFETY SWITCH THAT TURNS THE UNIT OFF SHOULD EITHER THE HOOD BE REMOVED OR THE LAMP DRAWER OPENED.

2. THE BODY OF THE UNIT SHALL, AS MINIMUM INCORPORATE THE FOLLOWING:

A. FRONT AND REAR OPERATED FADER CONTROLS

B. HORIZONTAL TRIM SHUTTERS

C. SPOT EDGE FOCUS ADJUSTING KNOB

3. THE UNIT SHALL HOUSE A SEVEN COLOR, SELF-CANCELING BOOMERANG

A. BOOMERANG SHALL BE RIGIDLY MOUNTED TO THE BODY OF THE FOLLOWSPOT

B. FRONT MOUNTED BOOMERANGS SHALL NOT BE ACCEPTABLE.

4. THE STAND/YOKE SHALL INCORPORATE:

A. HORIZONTAL SWING CONTROL LEVER

B. VERTICAL TILT CONTROL LEVER

C. HEIGHT ADJUSTMENT

D. OPTICAL

1. THE UNIT'S OPTICAL TRAIN SHALL CONSIST OF

A. 400 WATT HTI SINGLE ENDED LAMP

B. PRECISION ELECTROFORMED REFLECTOR

C. ONE COATED OPTIC AND TWO OPTICAL QUALITY GLASS LENSES

D. IRIS, HORIZONTAL TRIM SHUTTERS AND DOWSER FOR BEAM SHAPING CONTROL

E. INTERNAL SEVEN COLOR AUTOMATIC, SELF-CANCELLING BOOMERANG. FRONT MOUNTED BOOMERANGS ARE NOT ACCEPTABLE. SIC COLOR BOOMERANGS ARE NOT ACCEPTABLE.

2. THE LIGHT COLOR TEMPERATURE SHALL BE 5600° KELVIN (±200° K.).

3. REFLECTOR SHALL REFLECT 95% OF VISIBLE LIGHT AND ABSORB 90% OF INFRARED LIGHT AS HEAT

E. ELECTRICAL

1. HTI LAMP SYSTEM INPUT SHALL BE 100-120 V.AC, 60 HERTZ, SINGLE PHASE, 15 AMPERE MAXIMUM AND FUSED FOR 20 AMPERES. A UNIVERSAL BALLAST (UT) SHALL BE AVAILABLE FOR INTERNATIONAL ELECTRICAL REQUIREMENTS

2. EXTERNALLY CONTROLLABLE POWER SUPPLY WITH METER TO ALLOW UNITS TO MATCH OUTPUT

3. 12’ POWER CORD TERMINATED IN A NEMA-5-15P CONNECTOR

4. ONLY THOSE LAMPS RECOMMENDED BY FOLLOWSPOT MANUFACTURER ARE ACCEPTABLE.

F. PERFORMANCE

1. ADJUSTED FOR FLAT FIELD (APPROXIMATELY 70%) THE UNIT SHALL PRODUCE 256 FOOT CANDLES @ 100 FEET. IN SMALL SPOT

2. THE FIELD DIAMETER AT A 100 FOOT THROW SHALL BE AS WIDE AS 30 FEET.

LED STRIP LIGHT FIXTURES

12. 48” LED Strip Light – Used or New condition acceptable

a. The fixture shall be suitable for creating a wide range of flood, border, wall wash, effects and shall provide 8,000 hot lumens output. The fixture shall provide RGBA colour mixing and provide a CRI of 92. The fixture shall provide a smooth, linear dimming curve with a choice of HSI, Fx HSI, RGB, RGBA, RGB (*Magic Amber™) and sRGBI (Magic Amber) control modes. The fixture shall feature a built-in stand-alone mode with real-time triggering and built-in power supply.

b. Power input rating: 100-240V AC, 50-60 Hz, 700VA Power factor: 0.995 Power consumption: 660W (Measurements done with all LEDs at max. intensity. Measurements made at nominal voltage. Allow for a deviation of +/- 10%).

c. Power connector in/out: PowerCon

d. Data connectors in/out: XLR 5-pin

e. Control protocol: ANSI E1.11 USITT DMX 512-A Cooling system: fan cooled Operating temperature: 0°C to 40°C

f. Construction: Anodised aluminium extrusion

g. Colour: Black

h. Include 5’ Powercon-Edison Tail and rigging hardware

PART 4 CONTROL

LIGHTING CONSOLE AND ACCESSORIES

General

1. The lighting control console shall be a microprocessor-based system specifically designed to provide complete control of stage, studio and entertainment lighting systems. The console shall be the Element as manufactured by Electronic Theatre Controls, Inc., or equal.

2. The system shall provide control of 1024 outputs on 250 or 500 channels. Two universes of DMX512/RDM shall be accessible at the console via 5-pin XLR connectors. Additionally, output may be distributed over a 10/100 MB Ethernet network using Net3/ACN, ETCNet 2, Avab and/or ArtNet protocols. The user shall be able to control the application of protocols at an individual address level.

3. The system shall support full bi-directional RDM communication with compatible devices via Net3 DMX/RDM Gateways. RDM communication shall adhere to ANSII standard E1.20-2006 Entertainment Technology – RDM – Remote Device Management Over DMX512 Networks. Supported RDM features shall include:

   a. Discovery and identification of RDM capable devices

   b. Setting of start addresses, operating modes and additional settings as exposed by connected devices and controllable via RDM

   c. Viewing of Sensor data as provided by connected devices.

   d. Error reporting as provided by connected devices.

4. A maximum of 10,000 cues, 1000 groups, 1000 Intensity Palettes, 1000 Color Palettes, 1000 Focus Palettes, 1000 Beam Palettes, 1000 effects, 1000 macros and 1000 curves may be contained in non-volatile electronic memory and stored to an onboard solid state hard drive or to any USB storage device.

5. The console may be placed in Tracking or Cue Only mode by the user as a system default and overridden on individual record/update actions as required. HTP/LTP intensity flag, proportional, intensity master or manual master fade control as well as independent may be placed on the cue list. It shall be possible for a cue list to contribute to playback background states or withheld from such contribution.

6. A Master Playback fader pair and dedicated Grand Master/Blackout shall be provided.

7. The console shall provide 40 or 60 pageable faders and bump buttons that may be operated in either LTP channel or HTP/LTP submaster mode. The console shall support a total of 300 submasters.

8. A high-resolution level wheel shall be provided to control intensity for selected channels and scrolling/zooming within selected displays. On-demand moving light controls shall be provided for control of non-intensity parameters. Non-intensity parameters shall be controllable via both these on-demand and keypad controls in a fully interactive manner.

9. Virtual moving light controls shall provide mouse/touch-based tools for all parameters. The tools shall display the current value for each parameter and shall provide controls for adjusting each parameter.

10. Control and programming features for automated devices shall also include: a standard library of fixture profiles, the ability to copy and edit existing profiles and create new profiles, patch displays including channel and output addressing, 16-bit fade resolution, color characterization allowing color mixing and storing in Hue and Saturation or native device values.

11. System information, including playback status, live output and blind values for all record targets shall be displayed on a maximum of two external high-resolution DVI monitors, or one Display port monitor, which may also be touch or multi-touchscreen(s). Only one display shall be required for operation. Content of all displays and individual workspaces shall be zoomable. Each display shall have 3 definable workspaces; each workspace with split controls allowing sizing of frames. Single monitor snapshots with an on-screen browser shall provide rapid reconfiguration of workspaces.

12. The system shall direct user input through on-screen dynamic prompts and integral LEDs on console keys indicating current operating mode. A context sensitive on-line Help feature shall explain and provide an example of the operation of each feature of the system.

13. User-definable, interactive displays may be created. These displays, which can be used in live and blind operating modes, allow graphical layout of channels, desk buttons and programming tools. Standard symbols are provided, and the user may import his own symbols or graphics. Each symbol may be individually defined with data feedback characteristics. Non-interactive status information, such as a mirror of other user's command lines, may also be included in the display. A graphical browser is provided for fast selection of these views. Multiple zoom factors and placements may be stored and recalled for each display.

14. An optional, full-function detachable alphanumeric keyboard shall be supported. The keyboard shall allow labeling of channels, cues, groups, palettes, effects, macros, curves and the show. An integral virtual keyboard shall be provided.

15. A row of softkeys shall be provided, which change function based on the selection and context of the console. These softkeys shall be labeled on the connected external display.

16. Console software upgrades shall be made by the user via USB Flash drive; changing internal components shall not be required.

17. The console operating software shall be loaded into program execution memory from the internal hard drive when the console is powered. In the event of an uncontrolled shutdown, the console shall return to its last output state when power is restored.

18. Dimmer monitoring and configuration features shall be provided (in conjunction with ETC's Sensor+, Sensor 3 or FDX dimming systems) to allow indication of dimming system status, dimmer load monitoring and show specific configurations.

19. Show data may be created and modified on a personal computer, using Windows 7/8 operating systems, using a free offline editing application. The offline editor may also run natively on Intel-based Macintosh platforms using OS X. The program shall also allow output to visualization software supporting the same protocols as the lighting system. Systems that do not provide client software that may run natively on the Apple platform in this environment shall not be acceptable.

20. A PC using Windows 7/8 or an Intel-based Macintosh computer using OS X running the offline editing software shall be able to connect to a control system via the network and view current show data in a mirrored display environment.

21. The system shall allow remote control from a purpose-built wireless remote focus unit (Radio Focus Remote). Systems without dedicated hardware for remoted devices shall not be acceptable.

22. The system shall support a Telephone remote control that allows basic functions to be controlled from a standard wireless phone producing touch-tone signals. This allows the use of a standard telephone for a low cost remote control. Systems that do not allow this function shall not be acceptable.

23. The system shall support up to 32 individual Time Code Event lists.

24. Synchronized backup shall be provided by another control console or PC/Mac application with an ETCETCnomad dongle.

Controls and Playback

25. Manual Control and Programming Section

    a. The console keyboard shall be grouped by function. Major groupings shall be record target functions, numeric keys, level assignment functions, display navigation functions and controls.

    b. Non-intensity parameters may be set numerically or via the virtual moving light controls. This control shall be fully interactive.

    c. Only those parameters available for control in the active lighting system shall be displayed for control and parameters not appropriate for the current channel selection shall be suppressed.

    d. Lamp controls provide direct access to luminaire functions such as striking and dousing arc lamps and calibrating entire fixtures or individual mechanisms of fixtures, as provided by the luminaire manufacturer. User access to these features is normalized across all manufacturers for ease of use. Use of a “control channel” for accessing these functions shall not be required and systems requiring use of a control channel shall not be acceptable.

    e. Fixtures with color mixing systems may be set with direct native controls, as well as the Hue and Saturation controls and/or color picker. Color may also be set directly to a gel match, normalized to 3200K.

26. Playback Section

    a. The master fader shall consist of a 60mm Master Fader pair with associated Load, Go and Stop/Back buttons.

    b. It shall be possible to instantaneously halt an active cue, go back to the previous cue, manually override the intensity fade or manually override the entire fade.

    c. The playback status display shall indicate current, past and upcoming cues. In the cue list, timing may count dynamically with cue execution or remain static during countdown. Percentage of completion and remaining time shall always dynamically countdown for the active cue.

27. Integral Channel/Submaster Faders

a. Submaster and fader support shall be provided via 40 or 60 integral 45mm faders with bump buttons. These faders shall be pageable and shall operate in LTP channel and LTP or HTP submaster modes.

b. Channel mode shall allow the user access to intensity of the first 120 channels and shall operate with LTP logic. Faders that are not currently set to the same level as the corresponding channel shall have to be matched to that level before affecting channel output.

c. Channel fader values may be cleared without asserting LTP control.

d. Up to 300 proportional, fully overlapping additive or inhibitive submasters may be defined. Integral LEDs shall indicate submaster status as additive, inhibitive, fading, held and requiring a physical match. Each submaster may have fade up, dwell and down fade times. Each has a bump and assert/channel select button. Submasters may be set as independent, exclusive, shielded and proportional/intensity master control and effect mode.

e. The submaster blind buffer shall be linked directly to live playback allowing live editing of live submaster content via the command line.

f. Submasters may be set to fade to minimum value or release control to the previous owner as the submaster is faded toward zero. It shall be possible to disable a submaster from becoming a background state.

g. It shall be possible to set submaster values directly from the command line.

28. Grand Master

a. A dedicated 60mm grand master and blackout button are provided.

b. The grand master shall proportionally fade intensity values to zero. Blackout shall send all intensity outputs to zero. Non-intensity outputs shall not be affected. No additional configuration shall be required to withhold non-intensity values from Grand Master and Blackout control. Channel intensities that are impacted by Blackout/Grand Master shall be determined by the user.

Display Controls

29. The format of displays may be changed with a single control action.

30. Channel views may be displayed either in a expanded table view combining conventional channel symbols with table views for multi-parameter devices, in a channel summary view or in a user-defined magic sheet.

31. Flexi-channel shall change which channels are viewed in selected displays, based on a variety of different criteria, including all channels, patched channels, active/move channels, manual channels, selected channels and user-specified channel lists.

32. Absolute values of referenced data shall be viewable with a single control action.

33. Displays may be expanded across two external monitors.

34. Each display may have three individually configured workspaces. Each workspace supports discrete frame controls allowing user defined displays, sized as per user requirements.

Operating Modes

35. Live Mode

a. Channel lists may be constructed using the +, - and Thru keys, as well as direct selects.

b. Output values may be set with the keypad, level wheel and on-demand moving light controls. “Selected” channels shall be those last addressed and under keypad control.

c. Sneak shall be used to restore specified channels to background states, default values, or to send them to specified values, in user-specified or default times.

d. Selected channels may be set at a level or held to current values while all other channels are set to zero using Rem Dim. Toggling Rem Dim shall restore all unselected channels to original levels. The Rem Dim level shall be user definable both in setup and via the command line.

e. Channels may be recorded into groups for fast recall of commonly used selections. 1000 groups shall be available. Groups shall store selection order. The Offset function supports rapid creation of ordered groups, including reverse and random.

f. Parameter settings may be stored to Intensity, Focus, Color and Beam Palettes. All referenced data may be stored to whole numbers or to up to 99 decimal places between each whole number. It shall be possible to store 1000 of each palette type.

g. Any collection of channel data, as determined by the use of “Record” or selective store commands may be stored to palettes (as appropriate to the type).

h. A block flag may be placed on a channel or channel parameter to be included with a cue record action.

i. Cues may be recorded in any order. Up to 99 decimal cues may be inserted between any two whole number cues. Each cue may contain a maximum of twenty parts. Parameters may be automatically assigned to specific parts or assigned when the part is created.

j. It shall be possible to record cues and cue parts with the following information:

1) Any collection of channel data, as determined by the use of “Record” or selective store commands.
2) Cue Level timing and delays for Intensity Up and Intensity Down. Non-intensity parameter moves shall follow the Intensity Up time.
3) Follow time
4) Link instruction
5) Loop value
6) Block and/or preheat
7) Curve
8) Automark Disable

9) Label

10) Execute list to trigger other activity

k. Non-intensity channel parameters may be preset to an upcoming position using Automark. Automark shall set any stored parameter transitions in the cue just prior to intensity becoming active. Automark may be disabled on a cue or cue part basis, enabling a “live” move.

l. Any channel parameter may be stored with an effect instruction. These effects may contain relative offsets from current value or absolute instructions. Effects may be progressive action or on/off states. Entry and exit behaviors shall modify the channel parameters activity when beginning and ending the effect. The effect behavior may be edited live, with attributes such as size and rate modified and stored at a channel, effect or cue level.

m. Update may be used to selectively store modified parameter data quickly to that parameter’s current source or a user specified source. It shall be possible to update inactive record targets.

n. Recall From quickly pulls specified data from record targets into the current view. Recall from on an HTP basis shall be provided.

o. Copy To quickly copies selected data to specified record targets.

p. Address and channel check functions shall be provided.

q. Channel parameters may be “parked” at levels. Output addresses may also be parked directly. Parked levels shall not be added to any live record operations, nor may their output be modified until the parked element is “unparked”.

r. About shall provide detailed status of selected channels or specified record targets, including utilization information. About shall also access lamp control functions to calibrate devices, strike and douse arc sources. Use of a luminaire control channel for these functions shall not be acceptable.

s. Undo shall be used to sequentially step back through manual operations, record, update and delete actions. Redo functions shall be provided. Multiple undo commands may be executed at once.

t. Home shall set selected channels non-intensity parameters to their default values.

u. Macros may be created via live learn or blind modes. Each macro may be defined to run in the foreground or background when called. Startup and Shutdown macros may be stored.

v. Move shall allow all show data to be moved from one record target to another.

36. Blind

a. The Blind display allows viewing and modification of all record targets without affecting stage levels.

b. Record target data may be displayed in an expanded table view containing conventional symbols and table views for multi-parameter devices, in a summary view or a spreadsheet view, which allows quick data comparisons, move and replace with functions.

c. Changes made in blind displays shall be stored automatically.

d. It shall be possible to show or hide parameter data in spreadsheet views for simplicity in viewing/editing.

37. Patch Display

a. Patch shall be used to display and modify the system control channels with their associated library data and output addresses. Data may be viewed in “by channel” or “by address” mode.

b. Each channel may be provided with a proportional patch level, preheat, curve, label, Grand Master Exempt, Live/Dark Move Flag Disable, pan/tilt swap and invert functions.

c. Offset functions in patch shall allow selection of channel ranges and shall allow the user to establish a “custom” footprint for any device output.

d. Custom color wheels, color scrolls and gobo wheels shall be defined in patch. These devices shall be created with a simple table and graphical user interface supported by images of major manufacturers.

e. Copy to, Swap and Move functions shall be supported in patch.

f. The console shall support a one-to-one patch option on a file-new.

g. Library update functions shall identify modified profiles and allow the user the option of updating the profiles for previously stored showfiles.

h. The fixture editor shall provide the ability to define profiles when not found in the library.

38. Setup/Browser

a. Setup shall access system, show and device configurations.

b. The browser shall access show data storage, import, export, print to .pdf and clear functions, as well as show data utilities.

c. Print to .pdf functions shall be record target and/or channel list specific, shall be formatted for BW or color printing, and be provided in a summary or detailed view. Usage data shall be included.

d. Partial show file import shall be provided for all record targets and patch. Show file data may be merged.

e. ASCII files and Lightwright files may be opened within the application.

f. Files may be exported to ASCII and .csv.

g. The system shall support programming and playback of real time clock events, including cue, submaster and macro execution at specific times of specified days or at a time based on astronomical events.

h. A control screen shall be provided for network configuration, selecting date/time, software update controls, selecting functional language and/or keyboard for labeling option, as well as other system level tools.

i. Available languages for prompts, advisories and help messages shall include English, Bulgarian, German, Spanish, French, Italian, Japanese, Korean, Russian, Chinese, simplified and Chinese, traditional.

j. Supported keyboards shall include American, United Kingdom, French, German, Italian, Korean, Norwegian, Russian, Slovakian, Turkish, Swiss, Swedish, Finnish and Bulgarian

Dimmer Monitoring and Configuration

39. The lighting control system shall provide communication with an ETC Sensor+, Sensor3 or FDX dimming system for remote monitoring and configuration of show specific functions from within the console application.

40. Circuit level configuration and monitoring functions shall include but not be limited to:

    a. Control mode (dimmable, switched, latch-lock, always on, off or fluorescent).

    b. Curves

    c. Control threshold

    d. Min and Max Scale Voltage

    e. Preheat

    f. Scale load

41. Rack status messages shall include but not be limited to:

    a. State of UL924 panic closure

    b. DMX port error/failure

    c. Network error/failure

    d. A, B, C Phase below 90 or above 139 volts and headroom warning

    e. Ambient temperatures out of range

42. Circuit status shall include but not be limited to:

    a. Module type and location

    b. Output level

    c. Control Source

    d. Overtemp

43. Advanced circuit feedback shall include but not be limited to:

    a. Load higher or lower than recorded value

    b. DC detected on output

    c. SCR failed on/off

    d. Breaker trip

    e. Module has been removed

    f. Load failure

    g. Shutdown due to overtempt

Training Options

44. Training packages shall be available customizable to the individual venue preferences and needs. The level of training (beginner, intermediate or advanced) may be selected and training may be defined as an element of system commissioning or deferred to a later time.

Interface Options

45. The console shall support a variety of local interfaces.
    a. AC input
    b. DMX512-A/RDM outputs (two connectors)
    c. USB (a minimum of seven ports shall be provided for connecting devices such as an Alphanumeric keyboard, mouse, touch screens, USB Flash drive, etc.) The desk shall provide at one USB port on the face panel itself for easy access.
    d. Ethernet (two individually configurable ports)
    e. Two DVI video output connectors, supporting a maximum of two DVI monitors at 1280x1024 resolution minimum, touchscreen and multi-touch controls optional.
    f. One Display Port connector
    g. Contact Closure triggers via D-Sub connector
    h. Phone remote
    i. MIDI In/Out (Timecode, Show Control)
    j. XLR 3-Pin Female (Littlite)
    k. One eSATA port
    l. OSC and UPD Strings

Accessories

46. Net3 Radio Focus Remote

47. iRFR an iRFR Preview (applications for iPhone, IPod Touch and iPad)

48. aRFR (application for Android devices)

49. Net3 Remote Video Interface (Mirror Mode Only)

50. Net 3 Gateways
    a. Net3/ETCNet2 to DMX/RDM Gateway (one to four ports)
    b. Show Control Gateway
    c. I/O Gateway with 12 analog inputs, 12 SPDT contact outputs, RD232 interface

51. ETCnomad Software (Mirror Mode)

52. ETCnomad 1024 Kit (Backup)

Physical and Acoustical

53. All operator controls and console electronics for a standard system shall be housed in a single desktop console, not to exceed 32.9” wide, 17.9” deep, 5.1” high, weighing 30 pounds.

54. Console power shall be 95 – 240V AC at 50 or 60Hz, supplied via a detachable power cord.

55. At typical CPU utilization, the unit shall operate at ≤ 26 dBA.

PART 5: BILL OF MATERIALS

THEATRICAL BASE BILL OF MATERIALS

1	7141A1003-4	SR3-24 dimmer rack
1	7141A2005-4	SR3-24 door
1	7141A1003	CEM3 control module
16	7083A1022	D20 dimmer module
3	7083A1024	D20F fluorescent dimmer module
5	7050A1014	AFM air flow module
1	7180A1010	ERN
1	7180A1009	PARADIGM ACP architectural control processor
1	1782A1001	PARADIGM SMP station power module
6	7184A1401	PARADIGM Occupancy Sensor
3	1094A1005	ECPB DMXIN plug-in station
2	7181B2006	Unison Heritage 5 button station
1	7181B2007	Unison Heritage 7 button station
8	7099A1104B	Surface mount outlet box
8	7099A1050	U-Bolt kit (one pair)
1	4330A1120	ETC Element 40 250
1		10’ 5-Pin DMX cable
1	CAE 18X-LED	LED LXR Straight 3 Pin LITTLELITE
1	SMT1500	APC 1500VA 120V UPS

STRIP LIGHTS ADD/ALTERNATE BILL OF MATERIALS

1	4807	Pathway DMX splitter
3	1094A1015	ECPB DMX OUT
3	7081A2004-1	Surface mount back box
3	7099A1050	U-Bolt kit (one pair)
2	7083A1085	R20 relay module
- 2	7083A1022	DEDUCT D20 dimmer module
6	CHCF48NFRGBA	ColorForce 48 (edison)
6	7060A2009	400CC: C-Clamp
6		36” Safety Cable, Black
6		Stage pin male to edison female adapter
10		5’ Powercon jumper cable
10		10’ Powercon jumper cable
5		25’ Powercon jumper cable
10		5’ 5-Pin DMX cable
10		10’ 5-Pin DMX cable
5		25’ 5-Pin DMX cable

SOURCE FOUR ADD/ALTERNATE BILL OF MATERIALS

8	7060A1009	Source Four 36 degree fixture (stage pin)
9	7060A1007	Source Four 19 degree fixture (stage pin)
17	7060A2009	400CC: C-Clamp
17		36” Safety Cable, Black
15		5’ Stage Pin jumper cable
10		10’ Stage Pin jumper cable
5		25’ Stage Pin jumper cable
27	OSR HPL5X	Lamp HPL 575/115/x osram

BOX BOOM PIPE ADD/ALTERNATE BILL OF MATERIALS

4	7083A1022	D20 dimmer module
2	7099A1104B	Surface mount outlet box
4	7060A1008	Source Four 26 degree fixture (stage pin)
4	7060A2009	400CC: C-Clamp
4		36” Safety Cable, Black
4		5’ Stage Pin jumper cable

SPOTLIGHTS ADD/ALTERNATE BILL OF MATERIALS

2	LYC 1266	Superarc Standard Throw Followspot

PART 6 EXECUTION

INSTALLATION

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

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

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

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

MANUFACTURER'S SERVICES

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

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

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

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

E. Upon completion of the formal check-out, the factory engineer shall demonstrate operation and maintenance of the system to the owner's representatives. Training shall not exceed four working hours. Additional training shall be available upon request.

WARRANTY

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

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

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

Warranty shall not cover any labor expended or materials used to repair any equipment without manufacturer's prior written authorization.

END OF SECTION 260556

SECTION 260563 – EQUIPMENT CONNECTIONS AND COORDINATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide final connections to equipment and coordinate same in accordance with the Contract Documents.

1.2 WORK INCLUDED

A. Equipment to receive final connections shall include but not be limited to the following:

1. Lifts.
2. Motorized Equipment.
3. Appliances.
4. Owner Furnished Equipment.
5. Refrigeration Machines.
6. Kitchen Equipment.

B. SUBMITTALS

1. None required.

C. QUALITY ASSURANCE

1. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following or approved equal:

a. American National Standard Safety Code for Elevators Dumbwaiters and Moving Walks (ANSI A17.1).
b. Food and Drug Administration.
c. NFPA-96.

PART 2 - PRODUCTS

2.1 Only those products listed in Division 26 shall be employed.

PART 3 - EXECUTION

3.1 EXAMINATION OF DOCUMENTS

A. Prior to the submitting of bids, this Contractor shall familiarize himself with all conditions affecting the proposed installation of equipment requiring electrical connections and shall make provisions as to the cost thereof. Failure to comply with the intent of this paragraph shall in no way relieve the Contractor of performing all necessary work required for final electrical connections and equipment and the coordination thereof.

B. Connections shall be made in accordance with the manufacturers' recommendations and approved shop drawings.

1. ELEVATORS

a. Connections for and coordination of elevators shall include but not be limited to the following:
b. Dedicated power outlets one circuit per car and dedicated circuits for each cab's car lights and fans.
c. Empty raceway from each controller to nearest telephone backboard for telephone communications.
d. Fluorescent lighting fixture, switch and duplex outlet within each elevator pit.
e. Empty raceways from each elevator machine room to Fire Command Center. Size and quantity of raceways as per fire alarm system vendor's requirements.
f. Empty raceways from elevator machine room to remote elevator status panel. Size and quantity of raceways as per fire alarm system vendor's requirements.
g. Fused disconnect switches with feeders extended to and connected at each elevator controller. Fuse sizes shall be as per elevator vendor's requirements. All fuses shall be time delay type. Switches shall be installed within sight of motors and controllers.
h. Firefighter's telephone within elevator cab and appropriate connections at the elevator machine room and Life Safety System.

2. EQUIPMENT

a. Connections for and coordination of motors and equipment requiring electrical connections shall include but not be limited to the following:

1) Install motor controllers and disconnect switch for each motor and each piece of equipment.
2) Verify that the motor rotation is correct and reconnect if necessary.
3) Ground all equipment; provide separate ground wires in flexible, metal conduit and non-metallic conduit so as to provide an electrically continuous ground path.
4) Provide motor branch circuit conductors and connections to each individual motor controller and from each controller to the motor through an approved disconnect switch. Make final connection in minimum 24 inch length of liquid-tight, flexible, metal conduit.
5) Provide all necessary wiring and connections for interlocking, remote and automatic controls. Installation of equipment and wiring shall be in compliance with shop drawings and manufacturer's recommendations.
6) Where equipment is fed from branch circuit routed in or under the slab, terminate branch circuit at J-box on 2 foot rigid conduit stub-up and make final connection to equipment in liquid-tight, flexible, metal conduit. Provide suitable knee brace on conduit stub-up.
7) Where equipment is fed from overhead, support conduit feeder descending from ceiling on flanged floor fitting with conduit type fitting connecting to motor with 24-inch minimum of liquid-tight flexible steel conduit.
8) Where nameplate on equipment indicates fuse protection the disconnecting means shall be equipped with time delay fuses sized as per manufacturer's recommendations.

3. APPLIANCES

a. Connections for and coordination of appliances shall include but not be limited to the following:

1) The basic requirements for motors and equipment specified above shall apply where applicable.
2) Where cord and plugs are provided with the appliances this contractor shall coordinate the receptacle installation to match. Information on the Drawing as to receptacle type is for bidding purposes only.
3) Hard wired equipment shall be serviced by disconnecting means as indicated in the National Electrical Code.

4. OWNER FURNISHED EQUIPMENT

a. The requirements for equipment furnished by the owner for installation by this Contractor shall include but not be limited to the following:

1) The coordination of the proper delivery scheduling of such equipment.
2) The receiving and unloading of such equipment at the property line.
3) The inspection of such equipment for damages, defacement, corrosion, missing components, etc. at the job site. All deficiencies shall be recorded. Deficiencies occurring after inspection shall be corrected by this contractor at his cost.
4) The safe handling at secure storage of such equipment from unloading to the time of permanent installation.
5) The completion of field make up of internal wiring as required.
6) The lamping of equipment.
7) The installation of accessories on such equipment.
8) The installation of such equipment including the transportation of the equipment to the installation area, and the installation of all supports, fasteners, canopies, extensions, etc. required to insure safe support and adaptation to the finished structural, electrical and architectural conditions.
9) The final connections and grounding to the building electrical system including all necessary labor and materials including but not limited to junction box extensions, lug change outs, etc.
10) The testing of such equipment in its final location.

5. REFRIGERATION MACHINES

a. Connections for and coordination of refrigeration machines shall include but not be limited to the following:

1) The basic requirements for motors and equipment specified above shall apply where applicable.
2) Install motor controller furnished by others and provide six (6) conductors from load side of controller to lugs on machine.
3) Provide 120 volt circuit to oil pump and heater if required, coordinate requirements with approved shop drawings.

6. KITCHEN/LAUNDRY EQUIPMENT CONNECTIONS

a. This Contractor is to furnish the following electrical equipment/devices and make the following connections, but is not limited to:

1) All junction boxes, electrical outlets, stainless steel cover plates and switches not built into kitchen equipment.
2) All plugs and cords as noted on kitchen/laundry consultant's schedules.
3) Furnish and install shunt-trip branch circuit breakers or shunt-trip main circuit breakers as indicated and disconnect switches for fire control system shut-off

of kitchen equipment below hoods or ventilators as shown on the kitchen consultant's documents or the electrical documents.

4) Disconnect switches or other similar devices as required by code.
5) Electro-magnetic overload protection for air compressors/vacuum pumps in the laundry as noted.
6) Provide conduit and wiring, installation of electrical devices furnished by kitchen/laundry equipment trade and interwire between the following:

    a) Remote refrigeration equipment to evaporative coils.
    b) Control panels to water-type ventilators and exhaust/supply fans.
    c) Kitchen exhaust hoods/ventilators to fire control system and shut-offs.
    d) Signal from fire control system to local fire alarm panel with a dedicated zone per fire control system.
    e) All outlets and connections shown on electrical kitchen/laundry drawings are indicated for kitchen/laundry equipment only. Refer to electrical drawing(s) which indicates the general areas for outlets and devices for general purpose use.

A. The electrical kitchen/laundry plans indicate outlet type and location, and connection positions and loads. For final rough-in locations, refer to kitchen/laundry consultant's dimensioned plans. All dimensions shown are from finished floor and finished walls, unless otherwise noted.

B. Internal electrical work for fabricated food service equipment shall be internally wired and connected by kitchen equipment manufacturer for all kitchen equipment, except as noted.

C. All electrical work for fabricated food service equipment shall be completely wired by kitchen equipment manufacturer (except as noted above), to a junction box or pull box mounted on the equipment in an accessible position. Final connections between equipment, junction or pull boxes to the electrical panelboard (except as noted) to be the responsibility of this Contractor.

D. This Contractor shall furnish and install size, type and quantity of beverage dispensing raceways as indicated on the electrical documents. Final connections and bending radii to be verified with kitchen consultant.

END OF SECTION 260563

SECTION 260800 – ELECTRICAL SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes commissioning process requirements for electrical systems, assemblies, and equipment.

1.2 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. Integrated Systems: When referenced this encompasses all control, equipment and systems utilized in support of the facility.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.3 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA and as defined in the contract documents.

B. Attend construction phase commissioning meetings.

C. Attend test coordination meetings.

D. Participate in the electrical system maintenance orientation and inspection for assemblies and equipment as directed by the CxA.

E. Provide information requested by the CxA, including manufacturer cut sheets and shop drawings for final commissioning documentation.

F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

G. Provide detailed startup procedures.

H. Provide startup testing for all normal and emergency power equipment and shall coordinate and execute the electrical tasks for the commissioning checklists for all commissioned equipment.

I. Provide copies of all submittals as required including all changes thereto.

J. Facilitate the coordination of the commissioning and incorporate commissioning activities (the Commissioning Plan) into the Overall Project Schedule (OPS).

K. Ensure that all subcontractors and vendors execute their commissioning responsibilities according to the contract documents.

L. Provide training in the operation and maintenance of installed equipment for the Authority's personnel.

M. Review and accept construction checklists provided by the commissioning authority.

N. Complete startup reports and construction checklists as work is completed, and provide to the Commissioning Authority on a weekly basis.

O. Review and accept commissioning process test procedures provided by the Commissioning Authority.

P. Complete commissioning process test procedures (functional testing as detailed in functional testing checklists).

Q. Prepare O&M manuals, according to the contract documents, including clarifying and updating the original sequences of operation to as-built/as-tested conditions.

R. Cooperate with the CxA for resolution of issues recorded in the "Issues Log".

1.4 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual electrical systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing and operational sequencing per design documents.

D. Provide a final written report outlining the commissioning process and including commissioning field documentation

1.5 COMMISSIONING DOCUMENTATION

A. The contractor shall provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for electrical systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. System startup reports.
6. Certificate of readiness certifying that electrical systems, subsystems, equipment, and associated controls are ready for testing.
7. Test and inspection reports and certificates.
8. Corrective action documents.
9. Verification of contractually required static and dynamic testing reports.

1.6 SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that electrical systems, subsystems, and equipment have been installed, calibrated, and started, and that they are operating in the manner required by the Contract Documents.

B. Certify that electrical instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing and adjustments have been completed and that testing and adjustment reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as required and as directed by the CxA.

3.2 TESTING VERIFICATION

A. Prior to performance of testing, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least (ten) 10 days in advance of testing execution, and provide access for the CxA to witness testing procedures.

C. Provide technicians, instrumentation, and tools to verify testing of electrical systems at the direction of the CxA.

1. The CxA will notify the electrical contractor ten (10) days in advance of the date of field verification. Notice will not include data points to be verified.
2. The electrical contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item includes, emergency power system performance as defined by the authority having jurisdiction and operational sequence as determined in the contract documents including safeties, capacity and operational integrity.

4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning tests at the direction of the CxA.

B. Scope of electrical system testing can include, but is not limited to, entire electrical power distribution installation from central distribution to branch circuit to individual equipment served. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of interface to the building automation system.

D. The CxA with coordination of a certified testing agency, shall prepare detailed testing plans, procedures, and checklists for electrical systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. If tests cannot be completed because of a deficiency outside the scope of the electrical system, document the deficiency and report it to the Construction Management Representative. After deficiencies are resolved, reschedule tests.

I. Retesting: The CxA will direct the retesting of the equipment once at no “charge” to the Authority for their time. The CxA’s time and expenses incurred for a second retest, if required due to no fault of the CxA, will be reviewed by the Authority to determine the appropriate means of compensation to the CxA for extension of services. The functional testing shall include operating the system and components through each of the written sequences of operation, and other significant modes and sequences, including startup, shutdown, unoccupied mode, manual mode, staging, miscellaneous alarms, power failure, security alarm when impacted and interlocks with other systems or equipment. Sensors and actuators shall be calibrated during construction check listing by the installing contractors, and spot-checked by the CxA during functional testing.

3.4 ELECTRICAL SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Electrical Installation and Verification: Testing requirements are specified in Division 26. Provide submittals, test data, inspection records to the CxA.

1. Insulation resistance testing, mechanical integrity tests and inspections, ground testing, continuity, transformer-specific tests, emergency power system and manufacturer startup according to contract, agency and authority having jurisdiction requirements as indicated in Division 26. Electrical contractor shall prepare supporting documentation for compliance for copy to the CxA.

B. Short Circuit and Coordination Testing, Adjustment and Settings: Field testing and over-current protection coordination as specified in Division 26.

C. NFPA 110 Chapter 7 Installation Acceptance Testing shall be conducted, including “black start” and load bank testing per Division 26. All testing shall be conducted after manufacturer startup of equipment has been completed for the Emergency Generator, Automatic Transfer Switches and all components and accessories related to the normal and emergency power infrastructure. Time and duration for the load bank test shall be in compliance with the stepped operation for the time and duration as specified in NFPA 110 and not less than two (2) hours to a maximum time as the contract designates for 100% load for the resistive or inductive load bank. Time and durations for the “black start” testing shall be determined to be not less than 1.5 hours (As specified in Div. 26) or until all systems can be verified operational as intended for representative life safety, critical and emergency standby loads. Black start testing shall include, but not be limited to, the following field verification of the following systems:

1. Standby Generator
2. Automatic Transfer Switches
3. Load Banks
4. BMS Integration (and all associated equipment served)
5. Emergency Lighting
6. UPS
7. Fire alarm
8. Security
9. Communication Systems
10. Branch Circuit Distribution

D. The following equipment/systems will be commissioned in this project:

1. Standby Power System, including but not limited to the Generator, Automatic Transfer Switches, and all control systems.
2. Fire Alarm System in conjunction with the Authority Having Jurisdiction
3. Building Grounding System
4. Power distribution
5. Lighting and Lighting Controls
6. Branch circuit distribution

END OF SECTION 260800

SECTION 260943 - NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes a networked lighting control system comprised of the following components.

1. System Software Interfaces
    a. Visualization Interface
2. System Backbone and Integration Equipment
    a. System Controller
3. Wired Networked Devices
    a. Wall Stations
    b. Graphic Wall Stations
    c. Auxiliary Input/Output Devices
    d. Occupancy and Photocell Sensors
    e. Wall Switch Sensors
    f. Embedded Sensors
    g. Power Packs and Secondary Packs
    h. Networked Luminaires
    i. Relay and Dimming Panel
    j. Bluetooth® Low Energy Programming Device

B. The networked lighting control system shall meet all the characteristics and performance requirements specified herein.

C. The contractor shall provide, install and verify proper operation of all equipment necessary for proper operation of the system as specified herein and as shown on applicable drawings.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. Data Bus: Two wires used to communicate with bus connected devices.

C. DDC: Direct digital control.

D. Device: A collective term for connected devices, including drivers, luminaires, switches, relays, and similar.

E. Group: A set of devices that respond at the same time to messages on the data bus.

F. IP: Internet protocol.

G. IR: Infrared.

H. LAN: Local area network.

I. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

J. Scene: Digital light level associated with a preset.

K. TCP/IP: Transmission control protocol/Internet protocol.

L. VPN: Virtual private network.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Bill of Materials necessary to install the networked lighting control system.
2. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, relays, manual switches and plates, and conductors and cables.
3. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
4. Sound data including results of operational tests of central dimming controls.
5. Operational documentation for software and firmware.
6. Contractor Startup/Commissioning Worksheet (must be completed prior to factory start-up).

B. Shop Drawings:

1. Floor Plans: Location, orientation, and coverage area of each sensor; group designations; and other specific design symbols and designations as required to define the installation, location, and configuration of all control devices.
2. Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.
3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

1. Show interconnecting signal and control wiring, and interface devices that show compatibility of inputs and outputs.
2. For control interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.

B. Information Technology (IT) connection information pertaining to interconnection with facility IT networking equipment and third-party systems.

C. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

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

1.7 WARRANTY

A. Manufacturer's Warranty: The manufacturer shall provide a minimum five-year warranty on all hardware devices supplied and installed. Warranty coverage shall begin on the date of substantial completion.

1. Failures include, but are not limited to, the following:
   a. Software: Failure of input and output to execute switching or dimming commands.
   b. Failure of modular relays to operate under manual or software commands.
   c. Damage of electronic components due to transient voltage surges.

B. The hardware warranty shall cover repair or replacement any defective products within the warranty period.

1.8 QUALITY ASSURANCE

A. Product Qualifications

1. System electrical components shall be listed or recognized by a nationally recognized testing laboratory (e.g., UL, ETL, or CSA) and shall be labeled with required markings as applicable.
2. System shall be listed as qualified under DesignLights Consortium Networked Lighting Control System Specification V2.0.
3. System luminaires and controls are certified by manufacturer to have been designed, manufactured and tested for interoperability.
4. All components shall be subjected to 100% end of line testing prior to shipment to the project site to ensure proper device operation.
5. All components and the manufacturing facility where product is manufactured must be RoHS compliant.

B. Service and Support Requirements

1. Phone Support: Toll free technical support shall be available.
2. Remote Support: The contractor shall offer a remote support capability.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Acuity Brands Lighting, Inc.

2.2 SYSTEM DESCRIPTION

A. Interface with HVAC DDC System: Hardware and software shall interface with HVAC DDC system to monitor, control, display, and record data for use in processing reports. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

1. Communication Interface: Comply with ASHRAE 135. Lighting System shall include gateway with BACnet IP communication to interface to the DDC System. Communication shall interface with HVAC DDC system to remotely control and monitor lighting from HVAC DDC system operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through DDC system for HVAC. This will include at a minimum all input values (i.e. - motion sensors, light level/photocell sensors, light status points, energy readings, etc.) and commanded values (lighting on/off, lighting dimming %, etc.). All output points available via the BACnet shall be writable, such that the BAS/DDC system can override lighting commands from the lighting system. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

B. Surge Protective Device: Factory installed as an integral part of control components or field-mounted surge protective device complying with UL 1449, SPD Type 2.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.

E. Comply with UL 916 and UL 924 standards where applicable.

2.3 SYSTEM PERFORMANCE REQUIREMENTS

A. System Architecture

1. System shall have an architecture that is based upon three main concepts: (1) networkable intelligent lighting control devices, (2) standalone lighting control zones using distributed intelligence, (3) optional system backbone for remote, time based and global operation.
2. Intelligent lighting control devices shall have individually addressable network communication capability and consist of one or more basic lighting control components:

occupancy sensor, photocell sensor, relay, dimming output, contact closure input, analog 0-10V input, and manual wall station capable of indicating switching, dimming, and/or scene control. Combining one or more of these components into a single device enclosure shall be permissible so as to minimize overall device count of system.

3. System must be capable of interfacing directly with networked luminaires such that either low voltage network cabling or wireless RF communication is used to interconnect networked luminaires with control components such as sensors, switches and system backbone (see Control Zone Characteristics sections for each type of network connection, wired or wireless).
4. Networked luminaires and intelligent lighting control devices shall support individual (unique) configuration of device settings and properties, with such configuration residing within the networked luminaires and intelligent control devices.
5. Lighting control zones consisting of one or more networked luminaires and intelligent lighting control devices and shall be capable of providing automatic control from sensors (occupancy and/or photocell) and manual control from local wall stations without requiring connection to a higher-level system backbone; this capability is referred to as “distributed intelligence.”
    a. Lighting control zones (wired and wireless) of at least 128 devices per zone shall be supported.
6. Networked luminaires and intelligent lighting control devices shall have distributed intelligence programming stored in non-volatile memory, such that following any loss of power the lighting control zones shall operate according to their defined default settings and sequence of operations.
7. Lighting control zones shall be capable of being networked with a higher-level system backbone to provide time based control, remote control from inputs and/or systems external to the control zone, and remote configuration and monitoring through a software interface.
8. The system may include one or more system controllers that provide time-based control. The system controller also provides a means of connecting the lighting control system to a system software interface and building management systems via BACnet/IP or BACnet MS/TP protocol.
9. All system devices shall support firmware update, either remotely or from within the applications space, for purposes of upgrading functionality at a later date.

B. Wired Networked Control Zone Characteristics

1. Connections to devices within a wired networked lighting control zone and to backbone components shall be with a single type of low voltage network cable, which shall be compliant with CAT5e specifications or higher. To prevent wiring errors and provide cost savings, the use of mixed types of low voltage network cables shall not be permitted.
2. Devices in an area shall be connected via a “daisy-chain” topology; requiring all individual networked devices to be connected back to a central component in a “hub-and-spoke” topology shall not be permitted, so as to reduce the total amount of network cable required for each control zone.
3. System shall provide the option of having pre-terminated plenum rated low voltage network cabling supplied with hardware so as to reduce the opportunity for improper wiring and communication errors during system installation.
4. Following proper installation and provision of power, all networked devices connected together with low voltage network cable shall automatically form a functional lighting control zone without requiring any type of programming, regardless of the programming mechanism (e.g. software application, handheld remote, pushbutton). The “out of box” default sequence of operation is intended to provide typical sequence of operation so as to minimize the system startup and programming requirements and to also have functional lighting control operation prior to system startup and programming.

5. Once software is installed, system shall be able to automatically discover all connected devices without requiring any provisioning of system or zone addresses.
6. All networked devices shall have the ability to detect improper communication wiring and blink its LED in a specific cadence as to alert installation/startup personnel.
7. Networked luminaires and intelligent lighting control devices located in different areas shall be able to transmit and track information within at least 128 system-wide control zones to support required sequences of operation that may span across multiple areas. Occupancy and photocell commands shall be available across a single controller, and switch commands shall be available across single or multiple controllers. These shall also be referred to as global control zones.
8. Wired networked Wall stations shall provide the follow Scene Control Capabilities:
    a. Preset Scenes that can activate a specific combination of light levels across multiple local and global channels, as required.
    b. Profile Scenes that can modify the sequence of operation for the devices in the area (group) in response to a button press. This capability is defined as supporting “Local Profiles” and is used to dynamically optimize the occupant experience and lighting energy usage. Wall stations shall be able to manually start and stop Local Profiles, or the local profile shall be capable of ending after a specific duration of time between 5 minutes and 12 hours. Parameters that shall be configurable and assigned to a Local Profile shall include, but not be limited to, fixture light level, occupancy time delay, response to occupancy sensors (including enabling/disabling response), response to daylight sensors (including enabling/disabling response), and enabling/disabling of wall stations.
    c. 3-way / multi-way control: multiple wall stations shall be capable of controlling the same local and global control zones, so as to support “multi-way” preset scene and profile scene control.

C. System Integration Capabilities

1. The system shall interface with third party building management systems (BMS) to support two-way communication using the industry standard BACnet/IP or BACnet MS/TP protocols. The following system integration capabilities shall be available via BACnet/IP and BACnet MS/TP protocols:
    a. The system shall support control of individual devices, including, but not limited to, control of relay and dimming output.
    b. The system shall support reading of individual device status information. The available status will depend on the individual device type and capabilities, which may include but not be limited to, relay state, dimming output, power measurement, occupancy sensor status, and photocell sensor states or readings. All system devices shall be available for polling for devices status.
    c. The system shall support activation of pre-defined system Global Profiles.
2. The system shall support activation of Global Profiles from third party systems by receiving dry contact closure output signals or digital commands via RS-232/RS-485. (See Supported Sequence of Operations for further definition of Profile and Scene Preset capabilities.)
3. The system shall support activation of demand response levels from Demand Response Automation Servers (DRAS) via the OpenADR 2.0a protocol.

D. Supported Sequence of Operations

1. Control Zones
    a. Networked luminaires and intelligent lighting control devices installed in an area (also referred to as a group of devices) shall be capable of transmitting and tracking occupancy sensor, photocell sensor, and manual switch information within at least

48 unique control zones to support different and reconfigurable sequences of operation within the area. These shall also be referred to as local control zones.

2. Wall station Capabilities
   a. Wall stations shall be provided to support the following capabilities:
      1) On/Off of a local control zone.
      2) Continuous dimming control of light level of a local control zone.
   b. 3-way / multi-way control: multiple wall stations shall be capable of controlling the same local control zones, so as to support “multi-way” switching and/or dimming control.
3. Occupancy Sensing Capabilities
   a. Occupancy sensors shall be configurable to control a local zone.
   b. Multiple occupancy sensors shall be capable of controlling the same local zones. This capability combines occupancy sensing coverage from multiple sensors without consuming multiple control zones.
   c. System shall support the following types of occupancy sensing sequence of operations:
      1) On/Off Occupancy Sensing
      2) Partial-On Occupancy Sensing
      3) Partial-Off Occupancy Sensing
      4) Vacancy Sensing (Manual-On / Automatic-Off)
4. On/Off, Partial-On, and Partial-Off Occupancy Sensing modes shall function according to the following sequence of operation:
   a. Occupancy sensors shall automatically turn lights on to a designated level when occupancy is detected. To support fine tuning of Partial-On sequences the designated occupied light level shall support at least 100 dimming levels.
   b. Occupancy sensors shall automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. To support fine tuning of Partial-Off sequences the designated unoccupied dim level shall support at least 100 dimming levels.
   c. To provide additional energy savings the system shall also be capable of combining Partial-Off and Full-Off operation by dimming the lights to a designated level when vacant and then turning the lights off completely after an additional amount of time.
   d. Photocell readings, if enabled in the Occupancy Sensing control zone, shall be capable of automatically adjusting the light level during occupied or unoccupied conditions as necessary to further reduce energy usage. Additional requirements and details for photocell sensing capabilities are indicated under Photocell Sensing Capabilities.
   e. The use of a wall station shall change the dimming level or turn lights off as selected by the occupant. The lights shall optionally remain in this manually-specified light level until the zone becomes vacant; upon vacancy the normal sequence of operation, as defined above, shall proceed.
5. Vacancy Sensing mode (also referred to as Manual-On / Automatic-Off) shall function according to the following sequence of operation:
   a. The use of a wall station is required turn lights on. The system shall be capable of programming the zone to turn on to either to a designated light level or the previous user light level. Initially occupying the space without using a wall station shall not result in lights turning on.
   b. Occupancy sensors shall automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. To support fine tuning of Partial-Off sequences the designated unoccupied dim level shall support at least 100 dimming levels.
   c. To provide additional energy savings and an enhanced occupant experience, the system shall also be capable of dimming the lights when vacant and then turning the lights off completely after an additional amount of time.

d. To minimize occupant impact in case the area or zone is still physically occupied following dimming or shutoff of the lights due to detection of vacancy, the system shall support an “automatic grace period” immediately following detection of vacancy, during which time any detected occupancy shall result in the lights reverting to the previous level. After the grace period has expired, the use of a wall station is required to turn lights on.
e. Photocell readings, if enabled in the Occupancy Sensing control zone, shall be capable of automatically adjusting the light level during occupied or unoccupied conditions as necessary to further reduce energy usage. Additional requirements and details for photocell sensing capabilities are indicated under Photocell Sensing Capabilities.
f. At any time, the use of a wall station shall change the dimming level or turn lights off as selected by the occupant. The lights shall optionally remain in this manually-specified light level until the zone becomes vacant; upon vacancy the normal sequence of operation, as defined above, shall proceed.

6. To accommodate diverse types of environments, occupancy time delays before dimming or shutting off lights shall be specifiable for control zones between 15 seconds to 2 hours.

E. Photocell Sensing Capabilities (Automatic Daylight Sensing)

1. Photocell sensing devices shall be configurable to control a local zone.
   a. The system shall support the following type of photocell-based control:
      1) Continuous Dimming: The control zone automatically adjusts its dimming output in response to photocell readings, such that a minimum light level consisting of both electric light and daylight sources is maintained at the task. The photocell response shall be configurable to adjust the photocell setpoint and dimming rates.

F. Schedule Capabilities

1. System shall support the creation of time schedules for time-of-day override of devices including offsets from dusk and dawn.
2. System shall support blink warning and timed extension capabilities. At the end of a scheduled period, the system shall be capable of providing a visible “blink warning” 5 minutes prior to the end of the schedule. Wall stations may be programmed to provide timed overrides that turn the lights on for an additional period of time. Timed override duration shall be programmable for each individual device, zone of devices, or customized group of devices, ranging from 5 minutes to 12 hours.

G. Global Profile Capabilities

1. The system shall be capable of automatically modifying the sequence of operation for selected devices in response to any of the following: a time-of-day schedule, contact closure input state, manually triggered wired wall station input, RS-232/RS-485 command to wired input device, and BACnet input command. This capability is defined as supporting “Global Profiles” and is used to dynamically optimize the occupant experience and lighting energy usage.
2. Global profiles may be scheduled with the following capabilities:
   a. Global Profiles shall be stored within and executed from the system controller (via internal timeclock) such that a dedicated software host or server is not required to be online to support automatic scheduling and/or operation of Global Profiles.
   b. Global Profile time-of-day schedules shall be capable of being given the following recurrence settings: daily, specific days of week, every “n” number of days, weekly, monthly, and yearly. Lighting control profile schedules shall support definition of start

date, end date, end after “n” recurrences, or never ending. Daylight savings time adjustments shall be capable of being performed automatically, if desired.

c. Global Profile Holiday Schedules should follow recurrent settings for specific US holiday dates regardless if they always occur on a specific date or are determined by the day/week of the month.

d. Global Profiles shall be capable of being scheduled to run according to timed offsets relative to sunrise or sunset. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.

e. Software management interface shall be capable of displaying a graphic calendar view of profile schedules for each control zone.

3. System Global Profiles shall have the following additional capabilities:

a. Global Profiles shall be capable of being manually activated directly from the system controller, specially programmed wired input devices, scene capable wired wall stations, and the software management interface.

b. Global Profiles shall be selectable to apply to a single device, zone of devices, or customized group of devices.

c. Parameters that shall be configurable and assigned to a Global Profile shall include, but not be limited to, fixture light level, occupancy time delay, response to occupancy sensors (including enabling/disabling response), response to daylight sensors (including enabling/disabling response), and enabling/disabling of wall stations.

4. A backup of Local and Global Profiles shall be stored on the software’s host server such that the Profile backup can be applied to a replacement system controller or wired wall station.

H. System shall support automated demand response capabilities with automatic reduction of light level to at least three levels of demand response.

2.4 SYSTEM SOFTWARE INTERFACES

A. Visualization and Programming Interfaces

1. System shall provide an optional web-based visualization interface that displays graphical floorplan.

2. Graphical floorplan shall offer the following types of system visualization:

a. Full Device Option - A master graphic of the entire building, by floor, showing each control device installed in the project with zones outlined. This shall include, but not be limited to, the following:

1) Controls embedded light fixtures
2) Controls devices not embedded in light fixtures
3) Daylight Sensors
4) Occupancy Sensors
5) Wall Switches and Dimmers
6) Scene Controllers
7) Networked Relays
8) Wired Bridges
9) System Controllers
10) Wired Relay Panels
11) Group outlines

b. Group Only Option - A master graphic of the entire building, by floor, showing only control groups outlined.

c. Allow for pan and zoom commands so smaller areas can be displayed on a larger scale simply by panning and zooming each floor’s master graphic.

d. A mouse click on any control device shall display the following information (as applicable):
   1) The device catalog number.
   2) The device name and custom label.
   3) Device diagnostic information.
   4) Information about the device status or current configuration is available with an additional mouse click.

2.5 SYSTEM BACKBONE AND SYSTEM INTEGRATION EQUIPMENT

A. System Controller

1. System Controller shall be multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.
2. System Controller shall have 32-bit microprocessor operating at a minimum of 1 GHz.
3. System Controller shall have minimum of 512MB memory, with a minimum of 4GB non-volatile flash, to support its own operating system and databases.
4. System Controller shall perform the following functions:
   a. Time-based control of downstream wired and wireless network devices.
   b. Linking into an Ethernet network.
   c. Integration with Building Management Systems (BMS) and Heating, Ventilation and Air Conditioning (HVAC) equipment.
   d. Connection to various software interfaces, including management interface, historical database and analytics interface, and visualization interface.
5. System Controller shall have an integral web server to support configuration, diagnostics and hosting of software interfaces.
6. Device shall have option for a graphical touch screen to support configuration and diagnostics.
7. Device shall have three RJ-45 networked lighting control ports for connection to any of the following:
   a. The graphical touch screen
   b. Wired communication bridges
   c. Direct connection to networked wired luminaires and intelligent lighting control devices (up to 128 total devices per port)
8. Device shall automatically detect all networked devices connected to it.
9. Device shall have an internal time clock used for astronomical and standard schedules.
10. Device shall have 2 switched RJ-45 10/100 BaseT Ethernet ports for local area network (LAN) connection.
    a. Ethernet connection shall support daisy chain wiring to other lighting control system LAN devices.
    b. Ethernet connection shall support IPv4 and shall be capable of using a dedicated static or DHCP assigned IP address.
11. Device shall have 2 x USB 2.0 Expansion ports for 802.11 Wi-Fi Adapter enabling wireless connectivity including:
    a. Hot Spot
    b. Access Point
    c. Client
12. Each System Controller shall be capable of managing and operating at least 750 networked devices (wired or wireless).
    a. Multiple System Controllers may be networked together via LAN connection to scale the system up to 20,000 networked devices.

13. System Controller shall support BACnet/IP and BACnet MS/TP protocols to directly interface with BMS and HVAC equipment without the need for additional protocol translation gateways.
    a. BACnet MS/TP shall support 9600 to 115200 baud rate.
    b. System Controller shall be BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.
14. System controller shall contain a “FIPS 140-2 Level 1 Inside” cryptographic module.
15. System controller shall support RESTful API control of BACnet objects, user management, date and time, and file management.
16. System controller shall be available within a NEMA 1 enclosure with Class 1 and Class 2 separation
    a. Enclosure shall support power input power of 120-277VAC, or optional 347

B. Digital Electronic Time Clock (DTC)

1. Wired Networked Wall Switches, Dimmers, Scene Controllers
    a. Devices shall recess into single-gang switch box and fit a standard GFI opening.
    b. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
    c. All switches shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
    d. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
    e. Devices with mechanical push-buttons shall be made available with custom button labeling.
    f. Wall switches & dimmers shall support the following device options:
        1) Number of control zones: 1, 2 or 4
        2) Control Types Supported:
            a) On/Off
            b) On/Off/Dimming
            c) On/Off/Dimming/Correlated Color Temperature Control for specific luminaire types
        3) Colors: Ivory, White, Light Almond, Gray, Black, Red
    g. Scene controllers shall support the following device options:
        1) Number of scenes: 1, 2 or 4
        2) Control Types Supported:
            a) On/Off
            b) On/Off/Dimming
            c) Preset Level Scene Type
            d) On/Off/Dimming/Preset Level for Correlated Color Temperature
            e) Reprogramming of other devices within daisy-chained zone so as to implement user selected lighting scene. This shall support manual start/stop from the scene controller, or optionally programmed to automatically end after a user selectable duration between 5 minutes and 12 hours.
            f) Selecting a lighting profile to be run by the system’s upstream controller so as to implement a selected lighting profile across multiple zones. This shall support manual start/stop from the scene controller, or optionally programmed to automatically end after a user selectable duration between 5 minutes and 12 hours.
        3) Colors: Ivory, White, Light Almond, Gray, Black, Red
2. Wired Networked Graphic Wall Stations
    a. Device shall surface mount to single-gang switch box.
    b. Device shall have a 3.5”, capacitive full color touch screen.

c. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply.
d. Device shall have a micro-USB style connector for local computer connectivity.
e. Communication shall be over standard low voltage network cabling with RJ-45 connectors.
f. Device shall enable user supplied screen saver image to be uploaded within one of the following formats: jpg, png, gif, bmp, tif.
g. Device shall enable configuration of all switches, dimmers, control zones, and lighting preset scenes via password protected setup screens.
h. Graphic wall stations shall support the following device options:
    1) Number of control zones: Up to 16
    2) Number of scenes: Up to 16
    3) Profile type scene duration: User configurable from 5 minutes to 12 hours
    4) Colors: White, Black

3. Wired Networked Auxiliary Input / Output (I/O) Devices
a. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½" knockout.
b. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
c. Auxiliary Input/Output Devices shall be specified as an input or output device with the following options:
    1) Contact closure or Pull High input
        a) Input shall be programmable to support maintained or momentary inputs that can activate local or global scenes and profiles, activate lights at a preconfigured level, ramp light level up or down, or toggle lights on/off.
    2) 0-10V analog input
        a) Input shall be programmable to function as a daylight sensor.
    3) RS-232/RS-485 digital input
        a) Input supports activation of up to 4 local or global scenes and profiles, and on/off/dimming control of up to 16 local control zones.
    4) 0-10V dimming control output, capable of sinking up to 20mA of current
        a) Output shall be programmable to support all standard sequence of operations supported by system.
    5) Digital control output via EldoLED LEDcode communication
        a) Output shall be programmable to support light intensity control, as well as optional correlated color temperature (CCT) control, of the connected luminaire.

4. Wired Networked Occupancy and Photosensors
a. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
b. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
c. Sensors shall utilize dual technology and one of its two technologies shall not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable.
d. All sensing technologies shall be acoustically passive, meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection

technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.

e. System shall have ceiling, fixture, recessed & corner mounted sensors available, with multiple lens options available customized for specific applications.
f. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
g. All sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
h. Sensor programming parameter shall be available and configurable remotely from the software and locally via the device push-button.
i. Ceiling mount occupancy sensors shall be available with zero or one integrated dry contact switching relays, capable of switching 1 amp at 24 VAC/VDC (resistive only).
j. Sensors shall be available with one or two occupancy “poles”, each of which provides a programmable time delay.
k. Sensors shall have optional features for photosensor/daylight override, automatic dimming control, and low temperature/high humidity operation.
l. Photosensor shall provide for an on/off set-point, and a dead band to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
m. Photosensor and dimming sensor’s set-point and dead band shall be automatically calibrated through the sensor’s microprocessor by initiating an “Automatic Set-point Programming” procedure. Min and max dim settings as well as set-point may be manually entered.
n. Dead band setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
o. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The secondary daylight zone shall be capable of being controlled as an “offset” from the primary zone.

5. Wired Networked Wall Switch Sensors
   a. Devices shall recess into single-gang switch box and fit a standard GFI opening.
   b. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
   c. All wall switch sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
   d. Devices with mechanical push-buttons shall provide tactile user feedback.
   e. Wall switches sensors shall support the following device options:
      1) User Input Control Types Supported: On/Off or On/Off/Dimming
      2) Occupancy Sensing Technology: PIR only or Dual Tech acoustic
      3) Daylight Sensing Option: Inhibit Photosensor
      4) Colors: Ivory, White, Light Almond, Gray, Black, Red
6. Wired Networked Embedded Sensors
   a. Network system shall have embedded sensors consisting of occupancy sensors and/or dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.
   b. Occupancy sensor detection pattern shall be suitable for 7.5’ to 20’ mounting heights.
   c. Embedded sensors shall support the following device options:
      1) Occupancy Sensing technology: PIR only or Dual Tech acoustic
      2) Daylight Sensing Option: Occupancy only, Daylight only, or combination Occupancy/Daylight sensor
7. Wired Networked Power Packs and Secondary Packs

a. Power Packs shall incorporate one optional Class 1 relay, optional 0-10 VDC dimming output, and contribute low voltage Class 2 power to the rest of the system.
b. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC) and carry a plenum rating.
c. Secondary Packs shall incorporate the relay and 0-10 VDC or line voltage dimming output, but shall not be required to contribute system power.
d. Power Supplies shall provide system power only, but are not required to switch line voltage circuit.
e. Auxiliary Relay Packs shall switch low voltage circuits only, capable of switching 1 amp at 40 VAC/VDC (resistive only).
f. Communication shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors. Secondary packs shall receive low voltage power via standard low voltage network cable.
g. Power Pack programming parameters shall be available and configurable remotely from the software and locally via the device push-button.
h. Power Pack shall securely mount through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast/driver channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
i. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
j. Power/Secondary Packs shall be available with the following options:
    1) Power Pack capable of full 16-Amp switching of all normal power lighting load types, with optional 0-10V dimming output capable of up to 100mA of sink current.
    2) Secondary Pack with UL924 listing for switching of full 16-Amp Emergency Power circuits, with optional 0-10V dimming output capable of up to 100mA of sink current.
    3) Power and Secondary Packs capable of full 20-Amp switching of general purpose receptacle (plug-load) control.
    4) Secondary Pack capable of full 16-Amp switching of all normal power lighting load types.
    5) Secondary Pack capable of 5-Amps switching and dimming 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).
    6) Secondary Pack capable of 5-Amps switching and dimming of 120/277 VAC magnetic low voltage transformers.
    7) Secondary Pack capable of 4-Amps switching and dimming of 120 VAC electronic low voltage transformers.
    8) Secondary Pack capable of louver/damper motor control for skylights.
    9) Secondary Pack capable of providing a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.
    10) Secondary Pack capable of switching 1 amp at 40 VAC/VDC (resistive only) with the intent to provide relay signal to auxiliary system (e.g. BMS).
    11) Power Supply capable of providing auxiliary bus power (no switched or dimmed load).

8. Wired Networked Luminaires
    a. Networked luminaire shall have a mechanically integrated control device.

b. Networked LED luminaire shall have two RJ-45 ports available (via control device directly or incorporated RJ-45 splitter).
c. Networked LED luminaire shall be able to digitally network directly to other network control devices (sensors, photocells, switches, dimmers).
d. Networked LED luminaire shall provide low voltage power to other networked control devices (excluding EMG and CCT capable versions).
e. System shall be able to turn on/off specific LED luminaires without using a relay, if LED driver supports “sleep mode.”
f. System shall be able to maintain constant lumen output over the specified life of the LED luminaire (also called lumen compensation) by automatically varying the dimming control signal to account for lumen depreciation.
g. System shall indicate (via a blink warning) when the LED luminaire is no longer able to compensate for lumen depreciation.
h. System shall be able to provide control of network luminaire intensity, in addition to correlated color temperature of specific LED luminaires.
i. System shall be able to provide control of network luminaire intensity, in addition to dynamic features, such as grayscale and color accent of specific LED luminaires.

9. Wired Networked Bluetooth® Low Energy Programming Device
   a. Device shall be plenum rated and be inline wired, screw mountable.
   b. Communication and low voltage power shall be delivered to device via standard low voltage network cabling with RJ-45 connectors.
   c. Bluetooth Low Energy connection shall allow connection from smartphone application for programming device settings within the local daisy-chain zone.
      1) Device shall provide visual indication of remote Bluetooth connection via LED integrated into device enclosure such that it is visible from all angles while the zone is being programmed.

2.6 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than manufacturer’s recommendation or requirements.

B. Class 2 Control Cables: Multiconductor cable with copper conductor not smaller than manufacturer’s recommendation or requirements.

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than manufacturer’s recommendation or requirements.

D. Digital and Multiplexed Signal Cables: UTP cable with copper conductors, complying with Category 5e for horizontal copper cable.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Installation Procedures and Verification

1. The contractor shall review all required installation and pre-startup procedures with the manufacturer’s representative through pre-construction meetings.

2. The contractor shall install and connect the networked lighting control system components according to the manufacturer's installation instructions, wiring diagrams, the project submittals and plans specifications.

B. Coordination with Owner's IT Network Infrastructure

1. The contractor is required to coordinate with the owner's representative to secure all required network connections to the owner's IT network infrastructure.
   a. The contractor shall provide to the owner's representative all network infrastructure requirements of the networked lighting control system.
   b. The contractor shall provide to the manufacturer's representative all necessary contacts pertaining to the owner's IT infrastructure, to ensure that the system is properly connected and started up.

C. Documentation and Deliverables

1. The contractor shall document installed location of all networked devices, including networked luminaires. This includes providing as-built plan drawing showing device address barcodes corresponding to locations of installed equipment.
2. The contractor is responsible for the following additional documentation to the manufacturer's representative if visualization / graphical floorplan software is provided as part of bid package:
   a. As-Built floor plan drawings showing device address locations required above. All documentation shall remain legible when reproducing\scanning drawing files for electronic submission.
   b. As-Built electrical lighting drawings (reflected ceiling plan) in PDF and CAD format. Architectural floor plans shall be based on as-built conditions.
      1) CAD files shall have layers already turned on/off as desired to be shown in the graphical floorplan background images. The following CAD elements are recommended to be hidden to produce an ideal background graphical image:
         a) Titleblock
         b) Text- Inclusive of room names and numbers, fixture tags and drawings notes
         c) Fixture wiring and homeruns
         d) Control devices
         e) Hatching or poché of light fixtures or architectural elements
      2) CAD files shall be of AutoCAD 2013 or earlier. Revit file overall floor plan views shall be exported to AutoCAD 2013.

3.2 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method:

1. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
2. Where run exposed, wiring shall be in surface mounted metallic wiremold.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, boxes, cabinets, and terminals. Comply with identification requirements specified in Section 260553 "Identification for Electrical Systems."

B. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with Section 260553 "Identification for Electrical Systems."

C. Label each device cable within 6 inches of connection to power supply or termination block.

3.4 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test continuity of each circuit.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. The contractor shall be responsible for testing of all low voltage network cable included in the bid. Contractor is responsible for verification of the following minimum parameters:
   a. Wire Map (continuity, pin termination, shorts and open connections, etc.)
   b. Length
   c. Insertion Loss
2. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

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

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service. This shall be included in the base bid and not be cause for an extra.

1. Upon completion of installation by the installer, including completion of all required verification and documentation required by the manufacturer, the system shall be started up and programmed.
   a. For CAT5 wired devices, low voltage network cable testing shall be performed prior to system startup.
2. System start-up and programming shall include:
   a. Verifying operational communication to all system devices.
   b. Programming the network devices into functional control zones to meet the required sequence of operation.
   c. Programming and verifying all sequence of operations.
3. Initial start-up and programming is to occur on-site.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the control units and operator interface.

END OF SECTION 260943

SECTION 262416 – PANELBOARDS

PART 1 - GENERAL

1.1 REFERENCES

A. The latest edition of: NEMA PB-1, UL-50, UL-67, ANSI C37.81.

1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Electronic-grade panelboards.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. MCCB: Molded-case circuit breaker

C. SS: Transient voltage surge suppressor.

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

C. Quality Control Submittals:

1. List of Completed Installations: If brand names other than those specified are proposed for use, furnish the name, address, and telephone number of at least 5 comparable installations that can prove the proposed products have operated satisfactorily for one year.
2. Company Field Advisor Data: Include:
   a. Name, business address and telephone number of Company Field Advisor secured for the required services.
   b. Certified statement from the Company listing the qualifications of the Company Field Advisor.
   c. Services and each product for which authorization is given by the Company listed specifically for this project.

D. Contract Closeout Submittals:
1. System acceptance test report.
2. Certificate: Affidavit, signed by the Company Field Advisor and notarized, certifying that the system meets the contract requirements and is operating properly.
1. 3. Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Engineer

E. Remaining paragraphs are defined in Division 01 Section "Submittal Procedures" as "Informational Submittals."

F. Qualification Data: For qualified testing agency.

G. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

H. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

I. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards. If panelboards are stored in an unconditioned area during cold weather, install temporary electric heating (1 W per 250 cubic inches of panelboard space) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect, Construction Manager and Owner no fewer than (14) fourteen days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Construction Manager's written permission.
3. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: One spare of each type for each panelboard. Size shall be the most common size in the panelboard.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Flush- and surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
b. Outdoor Locations: NEMA 250, Type 3R.
c. Kitchen and Wash-Down Areas: NEMA 250, Type 3R.
d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Finishes:

a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Galvanized steel.
c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

4. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

B. Incoming Mains Location: Top and bottom.

C. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Neutral Bus: Neutral bus rated 100 percent of phase bus and UL listed as suitable for nonlinear loads.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Neutral Lugs: Rated 100 percent of phase lugs mounted on neutral bus.

E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

F. Future Devices: All spaces shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

G. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an NRTL.

2.2 Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. As produced by Cutler-Hammer/Eaton Corp. with LT Trim (Eaton EZ Trim shall not be considered), General Electric Co., Siemens or Square D Co., having:

1. Flush or surface type cabinets as indicated on the drawings.
2. Increased gutter space for gutter taps, sub-feed wiring, through-feed wiring, oversize lugs.
3. SUITABLE FOR USE AS SERVICE EQUIPMENT where used as service equipment.
4. Door and one piece trim. Door fastened to trim with butt or piano hinges. Trim fastened to cabinet with devices having provision for trim adjustment.
5. Yale No. 511S locks with brass cylinder rosette, blind fastened from inside of door. 2 No. 47 keys with each lock (Exception: Not more than 7 keys, total) or approved equal.
6. Solid copper bus bars. Ampere rating of bus bars not less than frame size of main circuit breaker.
7. Ratings as indicated on the drawings.
8. Full capacity copper neutral bus where neutrals are required.
9. Copper equipment grounding bus.
10. Sections designated “space” or “provision for future breaker” equipped to accept future circuit breakers.
11. Lock on devices for exit light, fire alarm, stair well circuits.
12. Provisions for padlocking circuit breaker handle in OFF position where indicated.
13. Directory.

14. Short circuit rating not less than indicated on panelboard schedule. Furnish fully rated equipment (the short circuit rating of the panelboard is equal to the lowest interrupting rating of any device installed in the panelboard).
15. Thermal magnetic, molded case, bolt-on circuit breakers:
    a. Mounting: Individually mounted main circuit breaker (when MCB is required), and group mounted branch/feeder circuit breakers to accommodate the circuit breaker style and panelboard construction.
    b. Components: See panelboard schedule for specific components required for each circuit breaker. In addition to the specific components, equip each circuit breaker with additional components as required to achieve a coordinated selective scheme between the main circuit breaker and the branch/feeder circuit breakers.
    c. Single pole 15 ATE and 20 ATE circuit breakers marked SWD where used as switches.
    d. Single pole and two pole 15, 20, and 30 ATE circuit breakers rated for high intensity discharge lighting loads when applicable.

2.3 NAMEPLATES

A. General: Precision engrave letters and numbers with uniform margins, character size minimum 3/16 inch high.
   1. Phenolic: Two color laminated engravers stock, 1/16 inch minimum thickness, machine engraved to expose inner core color (white).
   2. Aluminum: Standard aluminum alloy plate stock, minimum .032 inches thick, engraved areas enamel filled or background enameled with natural aluminum engraved characters.
   3. Materials for Outdoor Applications: As recommended by nameplate manufacturer to suit environmental conditions.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.
   5. Or Approved Equal.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

   1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: Circuit breaker or Lugs only as shown on drawings.

E. Branch Overcurrent Protective Devices: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.
5. Or Approved Equal.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only as shown on drawings.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 ELECTRONIC-GRADE PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.
5. Or Approved Equal.

B. Panelboards: NEMA PB 1; with factory-installed, integral SS; labeled by an NRTL for compliance with UL 67 after installing SS.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

D. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.

E. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.

F. Buses:

1. Copper phase and neutral buses; 100 percent capacity neutral bus and lugs.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.
5. Or Approved Equal.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: Relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Shunt Trip: 24 -V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
    f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
    g. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
    h. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section "Fuses."
2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
3. Auxiliary Contacts: One normally open and normally closed contact(s) that operate with switch handle operation.

2.6 PANELBOARD SUPPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Current Technology; a subsidiary of Danahar Corporation.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
4. Liebert Corporation.
5. Siemens Energy & Automation, Inc.
6. Square D; a brand of Schneider Electric.
   Or Approved Equal.

B. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, wired-in, solid-state, parallel-connected, non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:

1. Accessories:

   a. Fuses rated at 250-kA interrupting capacity.
   b. Fabrication using bolted compression lugs for internal wiring.
   c. Integral disconnect switch.
   d. Redundant suppression circuits.
   e. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
   f. LED indicator lights for power and protection status.
   g. Audible alarm, with silencing switch, to indicate when protection has failed.
   h. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

2. Peak Single-Impulse Surge Current Rating: 125 kA per mode/250 kA per phase.
3. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.

   a. Line to Neutral: 70,000 A.
   b. Line to Ground: 70,000 A.
   c. Neutral to Ground: 50,000 A.

4. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
5. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 or 208Y/120 -V, three-phase, four-wire circuits shall be as follows:

   a. Line to Neutral: 800 V for 480Y/277 or 400 V for 208Y/120.

b. Line to Ground: 800 V for 480Y/277 or 400 V for 208Y/120.
c. Neutral to Ground: 800 V for 480Y/277 or 400 V for 208Y/120.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards in accordance with NEMA Publication No. PB1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards in accordance with NEMA Publication No. PB1.1 “General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less”.

B. Flush Cabinets: Set flush cabinets so that edges will be flush with the finished wall line. Where space will not permit flush type cabinets to be set entirely in the wall, set cabinet as nearly flush as possible, and cover the protruding sides with the trim extending over the exposed sides of the cabinet and back to the finished wall line.

C. Directory: Indicate on typewritten directory the equipment controlled by each circuit breaker, and size of feeder servicing panelboard. For power panelboards also include ATE rating and feeder size for each breaker.

D. Remove the neutral to ground main/system bonding jumper unless the panelboard is used for a service entrance or if the panel if fed by a separately derived system. Turn the bonding jumper over to the Engineer.

E. Identification:
1. Use nameplates, or stencil on front of each panelboard with white paint, “LV-1*, HV-1*, etc.” in 1/2 inch lettering corresponding to panelboard designations on the drawings, and electrical parameters (phase, wire, voltage).

2. Install a nameplate on each panelboard that explains the means of identifying each ungrounded system conductor by phase and system. Examples of nameplate statements:

   a. Identification of 120/208 Volt Circuit Conductors:
   2 wire circuit - white*, black, white.
   3 wire circuit - white*, black, red, white.
   4 wire circuit - white*, black, red, blue, white

   *White is used only as neutral. Where neutral is not required, black, red, or black, red, blue is used for phase to phase circuits.

   b. Identification of 277/480 Volt Circuit Conductors:
   2 wire circuit - natural gray**, brown, gray.
   3 wire circuit - natural gray**, brown, yellow, gray.
   4 wire circuit - natural gray**, brown, yellow, orange, gray

   **Natural gray is used only as neutral. Where neutral is not required, brown, yellow, or brown, yellow, orange is used for phase to phase circuits.

A. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration Controls for Electrical Systems."

B. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

C. Install overcurrent protective devices and controllers not already factory installed.

   1. Set field-adjustable, circuit-breaker trip ranges.

D. Install filler plates in unused spaces.

E. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

F. Arrange conductors in gutters into groups and bundle and wrap loosely with wire ties after completing load balancing.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing of surge suppressors and other electronic devices with adjustment capabilities.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit. ANY PANEL WITH INTEGRAL SS UNIT SHALL HAVE SS UNIT DISCONNECTED PRIOR TO ANY MEGGAR TESTING.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262726 – WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Wall-box motion sensors.
3. Snap switches and wall-box dimmers.
4. Wall-switch and exterior occupancy sensors.
5. Cord and plug sets.
6. Multioutlet assemblies.

B. Related Sections include the following:

1. Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

1.4 SUBMITTALS

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

B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

1.7 EXTRA MATERIALS

A. Furnish extra materials described in subparagraphs below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).
5. Or Approved Equal.

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide products by one of the following:

a. Cooper; 5351 (single), 5352 (duplex).
b. Hubbell; HBL5351 (single), CR5352 (duplex).
c. Leviton; 5891 (single), 5352 (duplex).
d. Pass & Seymour; 5381 (single), 5352 (duplex).
e. Or Approved Equal.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide products by one of the following:

a. Cooper; XGF20.
b. Hubbell; GF5352.
c. Leviton; 6898.
d. Pass & Seymour; 2084.
e. Bryant
f. Or Approved Equal.

2.4 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Furnished on equipment provided by owner.
2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.5 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide products by one of the following:

a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A:

1. Products: Subject to compliance with requirements, provide products by one of the following:

a. Cooper; 2221PL for 120 V and 277 V.
b. Hubbell; HPL1221PL for 120 V and 277 V.
c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
d. Pass & Seymour; PS20AC1-PLR for 120 V.

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Key-Operated Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide products by one of the following:

a. Cooper; 2221L.
b. Hubbell; HBL1221L.
c. Leviton; 1221-2L.
d. Pass & Seymour; PS20AC1-L.

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.6 RECEPTACLES

A. Specification Grade Receptacles:

1. Single receptacle, NEMA 5-15R (15A, 125 V, 2P, 3W); Bryant's 5251, Crouse-Hinds/AH's 5251, Hubbell's 5251, Leviton's 5251, Pass & Seymour's 5251, or approved equal.
2. Duplex receptacle, NEMA 5-15R (15A, 125 V, 2P, 3W); Bryant's 5252/5242, Crouse-Hinds/AH's 5252/5242, Hubbell's 5252/5242, Leviton's 5252/5242, Pass & Seymour's 5252/5242, or approved equal.
3. Single receptacle, NEMA 5-20R (20A, 125 V, 2P, 3W); Bryant's 5361/5351, Crouse-Hinds/AH's 5361/5351, Hubbell's 5361/5351, Leviton's 5361/5351, Pass & Seymour's 5351, or approved equal.
4. Duplex receptacle, NEMA 5-20R (20A, 125 V, 2P, 3W); Bryant's 5362, Crouse-Hinds/AH's 5352/5342, Hubbell's 5352, Leviton's 5352, Pass & Seymour's 5352, or approved equal.

B. Electric Clock Receptacles:

1. Single receptacle, NEMA 5-15R (15A, 125 V, 2P, 3W), brass or stainless steel face plate to match hardware; Bryant's 2828-G, 2828-GS, Crouse-Hinds/AH's 5708, Hubbell's 5233, 5235, Leviton's 5261-CH, Pass & Seymour's S3733, S3733-SS, or approved equal.

C. Ground Fault Interrupter Receptacles:

1. Duplex receptacle rated 15A (NEMA 5-15R), circuit-ampacity 20A; Bryant's GFR52FT, Crouse-Hinds/AH's GF5242, Hubbell's GF5252, Leviton's 6599, Pass & Seymour's 1591S, Daniel Woodheads 5252GF, or approved equal.
2. Duplex receptacle rated 20A (NEMA 5-20R), circuit ampacity 20A; Bryant's GFR53FT, Crouse-Hind/AH's GF5342, Hubbell's GF 5352, Leviton's 6899, Pass & Seymour's 2091S, Daniel Woodheads 5352GF, or approved equal.

D. Weather Resistant Ground Fault Interrupter Receptacles:

1. Duplex receptacle rated 15A (NEMA 5-15R), circuit-ampacity 20A; Cooper's WRVGF15W, Leviton's 002-W7599-00W, or approved equal.
2. Duplex receptacle rated 20A (NEMA 5-20R), circuit ampacity 20A; Cooper's WRVGF20W, Leviton's 002-W7899-00W, or approved equal.

E. Special Purpose Receptacles: Furnish matching nylon, polycarbonate or armored plug with each receptacle. Furnish matching wall plate with each receptacle (.040" brass, Type 302 stainless steel, weatherproof, threaded box type, as required):

1. Type A: NEMA 14-20R (3P, 4W, 20A, 125/250 V, W/G); Crouse-Hinds/AH's 5759, General Electric's 1420, Hubbell's 8410, or approved equal
2. Type B: NEMA 14-30R (3P, 4W, 30A, 125/250 V, W/G); Bryant's 9430FR, Crouse-Hinds/AH's 5744N, Hubbell's 9430A, Leviton's 278, Pass & Seymour's 3864, or approved equal.
3. Type C: NEMA 14-50R (3P, 4W, 50A, 125/250 V, W/G); Bryant's 9450FR, Crouse-Hinds/AH's 5754N, Hubbell's 9450A, Leviton's 279, Pass & Seymour's 3894, or approved equal.
4. Type D: NEMA 14-60R (3P, 4W, 60A 125/250 V, W/G); Bryant's 9460FR, Crouse-Hinds/AH's 9460N, Hubbell's 9460A, Pass & Seymour's 3871, or approved equal.
5. Type E: NEMA 10-20R (3P, 3W, 20A, 125/250 V); Bryant's 9326, Crouse-Hinds/AH's 9140, Hubbell's 6810, Pass & Seymour's 6810, or approved equal.
6. Type F: NEMA 10-30R (3P, 3W, 30A, 125/250 V); Bryant's 9303, Crouse-Hinds/AH's 9344N, Hubbell's 9350, Leviton's 5207, Pass & Seymour's 3860, or approved equal.
7. Type G: NEMA 10-50R (3P, 3W, 50A, 125/250 V); Bryant's 9306, Crouse-Hinds/AH's 7985N, Hubbell's 7962, Leviton's 5206GR, Pass & Seymour's 3890, or approved equal.
8. Type H: NEMA L5-15R (2P, 3W, 15A, 125 V, W/G); Bryant's 4710, Crouse-Hinds/AH's 4710, Hubbell's 4710, Pass & Seymour's 4710, or approved equal.
9. Type I: NEMA L5-20R (2P, 3W, 20A 125 V, W/G); Bryant's 70520FR, Crouse-Hinds/AH's 6200, Hubbell's 2310A, Pass & Seymour's L520-R, or approved equal.
10. Type J: NEMA L5-30R (2P, 3W, 30A, 125 V, W/G); Bryant's 70530FR, Crouse-Hinds/AH's 6330, Hubbell's 2610A, Leviton's 70530-FR, Pass & Seymour's L530-R, or approved equal.
11. Type K: NEMA L6-15R (2P, 3W, 15A, 250 V, W/G); Bryant's 70615FR, Crouse-Hinds/AH's 6560, Hubbell's 4560, Leviton's 70615FR, Pass & Seymour's 4560, or approved equal.
12. Type L: NEMA L6-20R (2P, 3W, 20A, 250 V, W/G); Bryant's 70620FR, Crouse-Hinds/AH's 6210, Hubbell's 2320A, Leviton's 70620-FR, Pass & Seymour's L620-R, Slater's L620R, or approved equal.
13. Type M: NEMA L6-30R (2P, 3W, 30A, 250 V, W/G); Bryant's 70630FR, Crouse-Hinds/AH's 6340, Hubbell's 2620, Pass & Seymour's L630-R, or approved equal.

2.6 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting .
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with lift cover, and listed and labeled for use in "wet locations while in use."

Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant while in use, die-cast aluminum with lockable cover.

B. Brass Wall Plates: .040 inch thick brass with brush brass finish; Bryant's 518 Series, Hubbell's B Series or 94 Series, Leviton's 81 Series, Pass & Seymour's B Series, or approved equal.

C. Stainless Steel Wall Plates: Type 302 stainless steel with satin finish; Bryant's 93 Series, Crouse-Hinds/AH's 93 Series, Hubbell's 93 Series, Leviton's 910 -40 Series, Pass & Seymour's 93 Series, or approved equal.

D. Weatherproof Covers: Crouse-Hinds WLRS, WLRD, Hubbell's 52, 74 Series, Pass & Seymour's 45 Series, or approved equal.

E. Weatherproof While In Use Covers:

1. Polycarbonate: Cooper Crouse-Hinds TP7488W, Pass & Seymour's (Legrand) WIUC10C, or approved equal.
2. Metallic: Hubbell's WP826 or WP826H, Thomas and Betts' (Red Dot) CKMUV or CKMU, Leviton's M5979-0GY or M5999-0GY, or approved equal

F. Covers for Threaded Type Boxes: Stamped sheet steel, gasketed device covers as produced by Crouse-Hinds Co., OZ/Gedney Co., or approved equal.++++++++++

2.7 EMERGENCY SHUTDOWN SWITCHES

A. Emergency Shutdown Pushbutton Switch: Square D. Co.'s Class 9001 or approved equal, Type K, pushbutton operator with the following:

1. Red mushroom button.
2. Transformer type red pilot light.
3. Legend red plate with words "Emerg. Stop".
4. NEMA 13 oil tight enclosure with cover riveted to boy.

B. Emergency Shutdown Key Operated Switch: Square D. Co.'s Class 9001 or approved equal, Type K, key operated selector switch with the following:

1. Key removable in both "ON" and "OFF" position.
2. NEMA 13 oil tight enclosure with cover riveted to box.

2.8 NAMEPLATES

A. Phenolic Type: Standard phenolic nameplates with 3/16 inch minimum size lettering engraved thereon.

B. Embossed Aluminum: Standard stamped or embossed aluminum tags, 3/16 inch minimum size lettering, as produced by Seton Name Plate Corp. or Tech Products Inc.

2.9 FLOOR SERVICE FITTINGS

A. Service fittings in first paragraph below are available for voice and data communication cabling as well as for power. Edit to suit Project.

B. Type: Modular, flush-type , dual-service units suitable for wiring method used.

C. Compartments: Barrier separates power from voice and data communication cabling.

D. Service Plate: Round, solid brass with satin finish.

E. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish for general receptacles; white for computer receptacles, unless otherwise indicated.

F. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 Category 6 jacks for UTP cable.

2.10 MULTIOUTLET ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Wiremold Company (The).
3. Or Approved Equal.

B. If not indicated on Drawings, add mounting heights, raceway sizes, and types and spacing of receptacle devices to paragraph below. Add descriptions of special features in assemblies such as fused receptacles, special-purpose switches, and channels for communication wiring.

C. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

D. Raceway Material: As shown on plans.

E. Wire: No. 12 AWG.

2.7 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices connected for general duty shall be grey; connected for computers shall be white, unless otherwise indicated or required by NFPA 70 or device listing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Install wiring devices in outlet boxes.

B. Local Switches:

1. Install local switches rated 15A, 120/277 V ac for switches unless otherwise shown on the drawings or specified.
2. Install switches indicated Sa, Sb, Sc, etc, for control of outlets, with corresponding letters on the same circuit.
3. Where more than one switch occurs at same location in a 120 volt system, arrange switches in gangs and cover with one face plate.
4. Install switches in a 277 volt system in separate single boxes if voltage between exposed live metal parts of adjacent switches exceeds 300 volts.

5. Install single and double pole switches so that switch handle is up when switch is in the “On” position.
6. Install key operated switches where shown on the drawings.

C. Receptacles:

1. Install Specification Grade receptacles, NEMA 5-15R, 15A, 125 V, 2P, 3W, for duplex receptacles and single receptacles unless otherwise shown on the drawings or specified.
2. Install receptacles with ground pole in the down position.
3. Install Weather Resistant Ground Fault Interrupter Receptacles in wet and damp locations.

D. Wall Plates:

1. Install wall plates on all wiring devices in dry locations, with finish to match hardware in each area.
2. Install hospital wall plates on Type HG receptacles.
3. Install blank wall plates on outlet boxes which are for future equipment except telephone outlets.
4. Install 5/8 inch bushed wall plates on telephone outlets.
5. Fasten wall plates with vandal resistant screws in patients’ area. Deliver 10 screw keys to the facility.

E. Weatherproof Covers: Install weatherproof covers on wiring devices in damp locations.

F. Weatherproof While In Use Covers: Install weatherproof while in use covers on wiring devices in wet locations.

G. Nameplates: Provide phenolic or embossed aluminum nameplate for each special purpose receptacle indicating phase, ampere and voltage rating of the circuit. Attach nameplate with rivets or tamperproof fasteners to wall plate or to wall above receptacle. Wall plates may be engraved with required data in lieu of separate nameplates.

H. Mats: Where flush plates are required over outlet boxes that cannot be set deep enough for the plates to fit closely over the finished wall surfaces, provide oak mats to fill the space between the finished wall surface and the plate.

I. Receptacles On Emergency Circuits: Install red colored receptacles. Engrave faceplates “EMERGENCY” in 3/16 inch high lettering and fill engraving with contrasting color filler material.

A. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.
5. Alternatively, if installed before wall repair or painting; provide protective covers for the devices. Replace any devices that have mortar, wallboard compound or are painted on visible or operative surfaces.

6. Openings or cuts around boxes, in wallboard or block walls, shall not exceed 1/8 inch. Coordinate repair of wall surface to match surrounding to comply with this requirement.

B. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

C. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

D. Receptacle Orientation:

1. Install ground pin GFCI receptacles so that wording is oriented for normal reading. Install ground pin of vertically mounted standard receptacles to match the orientation of GFCI receptacles.

E. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening. No opening in the wall shall be visible around the plate.

F. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

G. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Write on inside of device plate with indelible marker and use durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Test straight blade convenience outlets in patient-care areas for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz.

END OF SECTION 262726

SECTION 262812 – SAFETY SWITCHES

PART 1 - GENERAL

1.01 SUBMITTALS

A. Product Data: Catalog sheets, specifications and installation instructions.

PART 2 - PRODUCTS

2.01 SAFETY SWITCHES (SINGLE THROW)

A. NEMA 1, 3R, 4 (Stainless Steel), 12: Eaton/ Cutler-Hammer Inc.'s Heavy Duty Series, General Electric Co.'s Heavy Duty Series, Siemens Inc,'s Heavy Duty Series, Square D Co.'s Heavy Duty Series, or approved equal; having:
   1. Fuses, or unfused as indicated on drawings.
   2. Fused switches equipped with fuseholders to accept only the fuses specified in Section 262813 (UL Class RK-1, RK-5, L).
   3. NEMA 1 enclosure unless otherwise indicated on drawing.
   4. 240V rating for 120V, 208V, or 240V, circuits.
   5. 600V rating for 277V, or 480V circuits.
   6. Solid neutral bus when neutral conductor is included with circuit.
   7. Ground bus when equipment grounding conductor is included with circuit.
   8. Current rating and number of poles as indicated on drawings.

B. NEMA 4X: Crouse-Hinds Co.'s NST, Square D Co.'s Heavy Duty Special Application Safety Switches, or approved equal; having:
   1. Fuses, or unfused as indicated on drawings.
   2. Fused switches equipped with fuseholders to accept only the fuses specified in Section 262813 (UL Class RK-1, RK-5, L).
   3. Molded fiberglass-reinforced polyester NEMA 4X enclosure.
   4. 240V rating for 120V, 208V, or 240V, circuits.
   5. 600V rating for 277V, or 480V circuits.
   6. Solid neutral bus when neutral conductor is included with circuit.
   7. Ground bus when equipment grounding conductor is included with circuit.
   8. Current rating and number of poles as indicated on drawings.

2.02 NAMEPLATES

A. General: Precision engrave letters and numbers with uniform margins, character size minimum 3/16 inch high.
   1. Phenolic: Two color laminated engravers stock, 1/16 inch minimum thickness, machine engraved to expose inner core color (white).
   2. Aluminum: Standard aluminum alloy plate stock, minimum .032 inches thick, engraved areas enamel filled or background enameled with natural aluminum engraved characters.
   3. Materials for Outdoor Applications: As recommended by nameplate manufacturer to suit environmental conditions.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install switches so that the maximum height above the floor to the center of the operating handle does not exceed 6'-6".

B. Identify each safety switch, indicating purpose or load served:
   1. NEMA 1 Enclosures: Rivet or bolt nameplate to the cover.
   2. NEMA 12 Enclosures: Rivet or bolt and gasket nameplate to the cover.
   3. NEMA 3R, 4, 4X Enclosures: Attach nameplate to the cover using adhesive specifically designed for the purpose, or mount nameplate on wall or other conspicuous location adjacent to switch. Do not penetrate enclosure with fasteners.

C. Paint switches used for the fire protective signaling system with red paint and identify - "FIRE ALARM CIRCUIT CONTROL".

D. Paint switches used for oil burner emergency switch with red paint and identify "OIL BURNER".

END OF SECTION 262812

SECTION 262813 – FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Cartridge fuses rated 600 V and less.

1.2 SUBMITTALS

A. Product Data: For each fuse type indicated.

B. Operation and maintenance data.

1.3 MAINTENANCE

A. Spare Parts:
1. Six spare fuses of each size and category, including any accessories required for a complete installation.
2. Special tools if required for installation or removal of fuses.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NEMA FU 1.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussman, Inc.
2. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.
3. Ferraz Shawmut, Inc.
4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.
5. Or Approved Equal.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage

2.3 FUSE HOLDERS

A. Equipment provided shall be furnished with fuse holders to accommodate the fuses specified.

2.4 FUSES RATED 600V OR LESS

A. Fuses for Safety Switches (Motor, Lighting and Heating Circuits) and Service Disconnects:
   1. Cartridge Type (250 Volts, 600 Amperes or Less): Dual element time-delay, UL Class RK-1, 200,000 amperes R.M.S. symmetrical interrupting capacity:
      a. Mersen Inc.'s Type A2D-R.
      b. Cooper Industries Inc.'s/Bussman Div. Type LPN-RK-SP.
      c. Littlefuse Inc.'s Type LLNRK.
      d. Or approved equal
   2. Cartridge Type (600 Volts, 600 Amperes or Less): Dual element time-delay, UL Class RK-1, 200,000 amperes R.M.S. symmetrical interrupting capacity:
      a. Mersen Inc.'s Type A6D-R.
      b. Cooper Industries Inc.'s/Bussmann Div. Type LPS-RK-SPI.
      c. Littlefuse Inc.'s Type LLSRK-ID.
      d. Or approved equal
   3. Cartridge Type (600 Volts or Less - Above 600 Amperes): Current limiting, UL Class L, 200,000 amperes R.M.S. symmetrical interrupting capacity:
      a. Mersen Inc.'s Type A4BQ.
      b. Cooper Industries Inc.'s/Bussmann Div. Type KRP-C.
      c. Littlefuse Inc.'s Type KLPC.
      d. Or approved equal

PART 3 - EXECUTION

3.1 FUSE APPLICATIONS

A. Service Entrance: Class L, time delay 6r J, time delay.

B. Feeders: Class L, time delay 6r J, time delay.

C. Motor Branch Circuits: Class RK5, time delay.

D. Other Branch Circuits: Class RK5, time delay 6r J, time delay.

3.2 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.3 IDENTIFICATION

A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 262813

SECTION 262815 – ELEVATOR POWER MODULE SWITCH

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work of this section shall conform to the requirements of the Contract Documents.

1.02 SECTION INCLUDES

A. Provide Elevator Power Module Switch, fuses and accessories as required and specified on Contract Drawings to distribute electrical power to all Elevators.

1.03 RELATED SYSTEMS

A. Division 28 - Fire Alarm System

B. Division 14 - Elevators

C. Division 26 - Electricals

1.04 CODES

A. All work shall be performed in accordance with the latest edition of applicable standards, codes and laws.

1. NFPA 70
2. ANSI/ASME A17.1
3. IBC
4. NFPA 72

1.05 STANDARDS

A. Except as modified by governing codes, all equipment shall be manufactured in accordance with the latest applicable standards:

1. Enclosed Switches, UL 98

1.06 COORDINATION

A. Submit drawings showing the location of electrical equipment supplied as part of this specification section that requires work space clearance in accordance with NFPA 70 Article 110 Part II. Work space clearance, including height, shall be indicated on the drawing, indicating where other trades are restricted from locating equipment, ductwork or piping. Locations for equipment furnished under this section may be shown on consolidated drawings submitted under Specification Section 16050. These drawings will be coordinated with the other trades by the General Contractor. Any changes to these drawings during the course of the construction shall be coordinated with all trades through the General Contractor prior to installing the equipment. Changes required by other trades as a result of lack of coordination through the General Contractor shall be borne by the Electrical Contractor.

1.07 SUBSTITUTIONS

A. Substitutions shall comply with the requirements of the General Conditions and General Requirements. The names of manufacturers and model numbers have been used to establish types

of equipment and standards of quality. A submittal shall contain sufficient information to prove compliance with Contract Documents. This includes compliance with all pertinent sections of codes and standards as specified above.

1.08 SUBMITTALS

A. Submit shop drawings and product data under the provisions of the General Conditions.

B. Product Data: Provide manufacturer's catalog information showing dimensions, configurations, and methods of mounting and installation.

C. Submit listing of all types, sizes and quantity of fuses which will be installed including the location of each.

D. Spare fuses shall be supplied as required by Section 16491.

E. Coordination drawings

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Bussmann — Power Module Switch

B. Approved equal

2.02 GENERAL CONDITIONS & REQUIREMENTS

A. Provide Power Module Switch in a single NEMA enclosure with all necessary relay(s), control transformer and other options (as listed below), and as shown on drawings. The Power Module Switch shall be constructed, listed, and certified to the standards as listed in above. The Power Module Switch shall have an ampere rating as shown on the Contract Drawings, and shall include a horsepower rated fusible switch or circuit breaker with shunt trip capabilities. The ampere rating shall be based upon elevator manufacturer requirements. Switches shall utilize Class J Fuses. It shall include as an accessory, a 100 VA control power transformer with primary and secondary fuses. The primary voltage rating shall be **408** volts with a 120 volt secondary. It shall also contain an isolation relay (3PDT, 10 amp, 120V). The coil of the isolation relay shall be 120V AC. A normally open dry contact shall be provided by the Fire Alarm Safety System to energize the isolation relay and activate the shunt trip solenoid.

B. The module shall contain the following options:

C. Key to Test Switch

D. Green "On" Pilot Light

E. Isolated Full Capacity Neutral Lug

F. 1P Form C Mechanically Interlocked auxiliary contacts

G. Fire Alarm Voltage Monitoring Relay

H. NEMA 1 Enclosure

I. The module shall have been successfully tested to a short circuit raging at 100,000 amps RMS Symmetrical. All switches shall shunt trip upon 120V AC signal from remote fire alarm signal. Branch feeders shall be selectively coordinated and fed with an upstream supply overcurrent protective device at a minimum of 2:1 size ratio utilizing Low-Peak (Class J, RK1, or L) fuses.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All material installation shall be in accordance with manufacturer's recommendations and the provisions of applicable codes.

B. Fuses shall not be installed until equipment is ready to be energized.

END OF SECTION 262815

SECTION 262816 – ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Shunt trip switches.
4. Molded-case circuit breakers (MCCBs).
5. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of NRTL listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Submit on translucent log-log graph paper.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Manufacturer's field service report.

F. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Submit on translucent log-log graph paper.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Submit drawings showing the location of electrical equipment supplied as part of this specification section that requires work space clearance in accordance with NFPA 70 Article 110 Part II. Work space clearance, including height, shall be indicated on the drawing, indicating where other trades are restricted from locating equipment, ductwork or piping. Locations for equipment furnished under this section may be shown on consolidated drawings submitted under Division 26 Section “BASIC ELECTRICAL REQUIREMENTS.” These drawings

shall be coordinated with the other trades through the General Contractor. Any changes to these drawings during the course of the construction shall be coordinated with all trades through the General Contractor prior to installing the equipment. Changes required by other trades as a result of lack of coordination through the General Contractor shall be borne by the Electrical Contractor.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Fuse Pullers: Two for each size and type.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Specific fuse types noted on the drawings shall override general requirements of Division 26 section “FUSES.”

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.
5. Or Approved Equal.

B. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
3. Lugs: Mechanical type, suitable for number, size, and conductor material.
4. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.
5. Or Approved Equal.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 SHUNT TRIP SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussmann, Inc.
2. Ferraz Shawmut, Inc.
3. Littelfuse, Inc.
4. Or Approved Equal.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.

E. Accessories:

1. Oiltight key switch for key-to-test function.
2. Oiltight green ON pilot light.
3. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
4. Form C alarm contacts that change state when switch is tripped.
5. Three-pole, double-throw, fire-safety and alarm relay; 24-V dc coil voltage.
6. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.4 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

5. Or Approved Equal.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I^2t response.

F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

G. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

H. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

I. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered or remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
7. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

2.5 MOLDED-CASE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.
5. Or Approved Equal.

B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Features and Accessories:

1. Standard frame sizes and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
6. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.

2.6 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Kitchen and Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study".

END OF SECTION 262816

SECTION 263213 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes packaged engine-generator sets for use in applications with features as specified and indicated where engine generators will be used as the Standby power source for the system. Features shall include:

1. Spark ignited engine.
2. Unit-mounted cooling system.
3. Unit-mounted and remote-mounted control and monitoring.
4. Weatherproof, sound attenuated enclosure.
5. Fuel system.

B. Related Requirements:

1. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3 DEFINITIONS

A. Emergency Standby Power (ESP): Per ISO 8528: The maximum power available during a variable electrical power sequence, under the stated operating conditions, for which a generating set is capable of delivering in the event of a utility power outage or under test conditions for up to 200 hours of operation per year with the maintenance intervals and procedures being carried out as prescribed by the manufacturers. The permissible average power output (Ppp) over 24 hours of operation shall not exceed 70 percent of the ESP unless otherwise agreed by the RIC engine manufacturer.

B. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

C. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

D. EPS: Emergency power supply.

E. EPSS: Emergency power supply system.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Include thermal damage curve for generator.
3. Include time-current characteristic curves for generator protective device.
4. Include fuel consumption in gallons per hour at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
5. Include generator efficiency at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
6. Include air flow requirements for cooling and combustion air in cfm at 0.8 power factor, with air supply temperature of 95, 80, 70, and 50 deg F. Provide drawings showing requirements and limitations for location of air intake and exhausts.
7. Include generator characteristics, including, but not limited to kw rating, efficiency, reactances, and short-circuit current capability.
8. Thermal damage curve for generator
9. Time-current characteristics curves for generator protective devices
10. Sound test data, based on a free field requirement.

B. Shop Drawings:

1. Include dimensioned outline plans and elevations for engine-generator set and other components specified. Indicate access requirements affected by height of subbase fuel tank. Indicate dimensions, weights, and location and size of each field connection.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

1.5 INFORMATIONAL SUBMITTALS

A. Source quality-control reports, including, but not limited to the following:

1. Certified summary of prototype-unit test report.
2. Certified Test Report: Provide certified test report documenting factory test per the requirements of this specification, as well as certified factory test of generator set sensors per NFPA110 level 1.
3. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
4. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
5. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
6. Report of sound generation.
7. Report of exhaust emissions showing compliance with applicable regulations.
8. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

B. Field quality-control reports.

C. Certifications: Submit statement of compliance which states the proposed product(s) is certified to the emissions standards required by the location for EPA, stationary emergency application.

D. Warranty: Submit manufacturer's warranty statement to be provided for this Project.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
b. Operating instructions laminated and mounted adjacent to generator location.
c. Training plan.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
4. Tools: Each tool listed by part number in operations and maintenance manual.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 50 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

D. Comply with NFPA 37 (Standard For the Installation and Use of Stationary Combustion Engines and Gas Turbines).

E. Comply with NFPA 70 (National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702).

F. Comply with NFPA 110 (Emergency and Standby Power Systems) requirements for Level **1** emergency power supply system.

G. Comply with UL 2200

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five (5) years from date of registered commissioning and start-up.

2. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Only approved bidders shall supply equipment provided under this contract. Equipment by other named suppliers that meets the requirement of this specification are acceptable if approved not less than 2 weeks before scheduled bid date. Other suppliers are not acceptable.

1. Cummins Power Generation (Basis of Design)
2. Caterpillar
3. Detroit Diesel

B. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer. The supplier shall be the manufacturer’s authorized distributor, who shall provide initial start-up services, conduct field acceptance testing, and warranty service. The supplier shall have 24-hour service availability and factory trained service technicians authorized to do warranty service on all equipment supplied.

2.2 PERFORMANCE REQUIREMENTS

A. ASME Compliance: Comply with ASME B15.1.

B. NFPA Compliance:

1. Comply with NFPA 37.
2. Comply with NFPA 70.
3. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

C. UL Compliance: Comply with UL 2200.

D. Engine Exhaust Emissions: Comply with EPA Tier3 requirements and applicable state and local government requirements.

E. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

F. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 5 to 40 deg C.

2.3 ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

C. EPSS Class: Engine-generator set shall be classified as a Class 8 in accordance with NFPA 110.

D. Induction Method: Turbocharged.

E. Governor: Adjustable isochronous, with speed sensing. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.

F. Emissions: Comply with EPA NSPS emissions certified engine for stationary applications

G. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

H. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries, with capacity as required to operate as a unit as evidenced by records of prototype testing.
2. Output Connections: Three-phase, four wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

I. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 0.5 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds. On application of a 100% load step the generator set shall recover to stable voltage within 10 seconds.
3. Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state

operating band within five seconds. On application of a 100% load step the generator set shall recover to stable frequency within 10 seconds.

6. Output Waveform: At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.
7. Sustained Short-Circuit Current: (For engine-generator sets using a PMG-excited alternator) For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds without damage to generator system components. For a 1-phase, bolted short circuit at system output terminals, system shall regulate both voltage and current to prevent over-voltage conditions on the non-faulted phases.
8. Start Time: Comply with NFPA 110, Level 1, Type 10, system requirements. Ambient Condition Performance: Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.
9. Noise Output: Engine generator shall be tested by the manufacturer per ANSI S12.34. Data documenting performance shall be provided with submittal documentation.

J. Generator-Set Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.

    a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.

2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.

    a. Provide permanent magnet excitation for power source to voltage regulator.

10. Start Time: Comply with NFPA 110, Level 1, Type 10, system requirements.

2.4 ENGINE

A. Power Output Ratings: Continuous electrical output power rating for standby operation of not less than 60 kW, at 80 percent lagging power factor, 208/120-volt, three phase, [4]-wire, 60 hertz.

B. Fuel: Natural Gas

C. Rated Engine Speed: 1800RPM.

D. Engine Fuel System: The engine fuel system shall be installed in strict compliance to the engine manufacturer's instructions

E. Governor: Adjustable isochronous, with speed sensing. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.

F. Alternator shall be capable of accepting maximum load in a single step and be capable of recovering to a minimum of 90% of rated no load voltage. Following the application of the specified kVA load at near zero power factor applied to the generator set.

G. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component. The engine-generator nameplate shall include information of the power output rating of the equipment.

H. Fuel: Natural Gas, Spark Ignited, 4 cycle, radiator and fan cooled meeting all current EPA emissions standards as required to meet the required horsepower for the specified kW rating. Minimum displacement shall be 8.9 Liters, cast iron, in-line with 6 cylinders. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. The engine-generator shall produce full rated output at a gas pressure of 7" – 13" inches of water column. Two cycle engines are not acceptable. Engine accessories and features shall include:

    a. Carburetor.
    b. Fuel-Shutoff Solenoid Valves: One for each fuel source.
    c. Flexible Fuel Connectors: One for each fuel source.

    2. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
    3. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
    4. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

I. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

J. Outdoor Weather-Protective Sound Attenuating Housing

    1. The generator set shall be provided with a "Quiet-Site II" Level II sound-attenuated aluminum housing which allows the generator set to operate at full rated load in the

ambient conditions previously specified. The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of 75 dBA at any location 7 meters from the generator set in a free field environment. Housing configuration and materials used may be of any suitable design which meets application needs, except that acoustical materials used shall be oil and water resistant. No foam materials shall be used unless they can be demonstrated to have the same durability and life as fiberglass.

2. Hinged Doors: With padlocking provisions. Restraint/Hold back hardware to prevent door to keep door open at 180 degrees during maintenance. Rain lips over all doors.

3. Hardware: All hardware and hinges shall be stainless steel.

4. The enclosure shall be provided with a critical grade exhaust silencer, which is mounted inside of the enclosure, and allows the generator set package to meet specified sound level requirements. Silencer and exhaust shall include a raincap and rainshield.

5. Indoor and Outdoor Enclosures and Components: Powder-coated and baked over corrosion-resistant pretreatment and compatible primer. Manufacturer's standard color or as directed on the drawings.

6. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant and designed to minimize marring of the painted surface when removed for normal installation or service work.

7. Mounting Base: Suitable for mounting on sub-base fuel tank or housekeeping pad.

8. A weather protective enclosure shall be provided which allows the generator set to operate at full rated load with a static pressure drop equal to or less than 0.5 inches of water.

K. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

    a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
6. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
7. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.

8. Fan: Driven by multiple belts from engine shaft.
9. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
10. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

L. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 25 dB at 500 Hz.
2. Sound level measured at a distance of 25 feet (8 m) from exhaust discharge after installation is complete shall be 78 dBA or less.

M. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

N. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity and performance.
1. Designed for operation on a single 120 volt AC, single phase, 60 hertz power connection. Heater voltage shall be shown on the project drawings.
2. Provided with a 12VDC thermostat, installed at the engine thermostat housing

O. Starting System: 12-V electric, with negative ground.

1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified 60 seconds.
4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35 A minimum continuous rating.
9. Battery Charger: Current-limiting, automatic-equalizing and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:

a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg F (minus 40 deg C) to 140

deg F (plus 60 deg C) to prevent overcharging at high temperatures and undercharging at low temperatures.

c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.

d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.

e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

g. Provide LED indication of general charger condition, including charging, faults, and modes. Provide a LCD display to indicate charge rate and battery voltage. Charger shall provide relay contacts for fault conditions as required by NFPA110.

2.5 CONTROL AND MONITORING

A. Provide minimum run time control set for 15 minutes with override only by operation of a remote emergency-stop switch.

B. Comply with UL 508A.

C. Engine generator control shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit.

D. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. (Switches with different configurations but equal functions are acceptable.) When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.

E. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.

F. Configuration: Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel shall be powered from the engine-generator set battery. Panel features shall include the following:

1. Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6. Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.

G. Indicating Devices : As required by NFPA 110 for Level 1 system, including the following:

1. AC voltmeter (3-phase, line to line and line to neutral values).
2. AC ammeter (3-phases).
3. AC frequency meter.
4. AC kVA output (total and for each phase). Display shall indicate power flow direction.
5. Ammeter-voltmeter displays shall simultaneously display conditions for all three phases.
6. Emergency Stop Switch: Switch shall be a red “mushroom head” pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating.
7. AC Protective Equipment: The control system shall include over/under voltage, over current, short circuit, loss of voltage reference, and over excitation shut down protection. There shall be an overload warning, and overcurrent warning alarm.
8. Status LED indicating lamps to indicate remote start signal present at the control, existing alarm condition, not in auto, and generator set running.
9. A graphical display panel with appropriate navigation devices shall be provided to view all information noted above, as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall also include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.
10. Panel lighting system to allow viewing and operation of the control when the generator room or enclosure is not lighted.
11. DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control, and annunciate low or high voltage conditions. It shall also provide an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking).
12. EPS supplying load indicator.
13. Ammeter and voltmeter phase-selector switches.
14. DC voltmeter (alternator battery charging).
15. Engine-coolant temperature gage.
16. Engine lubricating-oil pressure gage.
17. Running-time meter.
18. Current and Potential Transformers: Instrument accuracy class.

H. Protective Devices and Controls in Local Control Panel: Shutdown devices and common visual alarm indication as required by NFPA 110 for Level 1 system, including the following:

1. Start-stop switch.
2. Overcrank shutdown device.
3. Overspeed shutdown device.
4. Coolant high-temperature shutdown device.
5. Coolant low-level shutdown device.
6. Low lube oil pressure shutdown device.
7. Air shutdown damper shutdown device when used.
8. Overcrank alarm.
9. Overspeed alarm.
10. Coolant high-temperature alarm.
11. Coolant low-temperature alarm.
12. Coolant low-level alarm.
13. Low lube oil pressure alarm.
14. Air shutdown damper alarm when used.
15. Lamp test.
16. Contacts for local and remote common alarm.
17. Coolant high-temperature prealarm.
18. Generator-voltage adjusting rheostat.
19. Main fuel tank low-level alarm.

20. Run-Off-Auto switch.
21. Control switch not in automatic position alarm.
22. Low cranking voltage alarm.
23. Battery-charger malfunction alarm.
24. Battery low-voltage alarm.
25. Battery high-voltage alarm.

I. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

J. Common Remote Panel with Common Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine-generator set battery.

K. The generator set shall be provided with a network communication module to allow LonMark compliant communication with the generator set control by remote devices. The control shall communicate all engine and alternator data, and allow starting and stopping of the generator set via the network in both test and emergency modes.

L. Control Interfaces for Remote Monitoring:

1. All control and interconnection points from the generator set to remote components shall be brought to a separate connection box. No field connections shall be made in the control enclosure or in the AC power output enclosure. Provide the following features in the control system:
2. Form "C" dry common alarm contact set rated 2A @ 30VDC to indicate existence of any alarm or shutdown condition on the generator set.
3. One set of contacts rated 2A @ 30VDC to indicate generator set is ready to load. The contacts shall operate when voltage and frequency are greater than 90% of rated condition.
4. A fused 10 amp switched 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.
5. A fused 20 amp 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.
6. The control shall be provided with a direct serial communication link for the LonWorks communication network interface as described elsewhere in this specification and shown on the drawings.

2.6 GENERATOR OVERCURRENT

A. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.

1. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with UL 489.

1. Tripping Characteristic: Designed specifically for generator protection.
2. Trip Rating: Matched to generator output rating.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H.

D. Temperature Rise: 105 / Class F environment.

E. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide12 lead alternator.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

G. Enclosure: Weatherproof.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.

1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
2. Maintain voltage within 30 percent on one step, full load.
3. Provide anti-hunt provision to stabilize voltage.
4. Maintain frequency within 10 percent and stabilize at rated frequency within 2 seconds.

I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

J. Subtransient Reactance: 12 percent, maximum.

K. Permanent Magnet Generator (PMG) shall provide excitation power for optimum motor starting and short circuit performance.

L. Voltage Regulator: SCR type, separate from exciter, providing performance as specified. The voltage regulation system shall be microprocessor-controlled, full wave rectified, and provide a pulse-width modulated signal to the exciter. No exceptions or deviations to these requirements will be permitted.

M. The alternator shall be provided with anti-condensation heater(s) in all applications where the generator set is provided in an outdoor enclosure, or when the generator set is

2.8 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters. In addition, the equipment engine, skid, cooling system, and alternator shall have been subjected to actual prototype tests to validate the capability of the design under the abnormal conditions noted in NFPA110. Calculations and testing on similar equipment which are allowed under NFPA110 are not sufficient to meet this requirement.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
1. Test engine generator set manufactured for this Project to demonstrate compatibility and functionality.
2. Full load run.
3. Maximum power.
4. Voltage regulation.
5. Steady-state governing.
6. Single-step load pickup.
7. Simulated safety shutdowns.
8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Engineer and Owner no fewer than ten working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Engineer's and Owner's written permission.

3.3 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Equipment Mounting:

1. Install packaged engine generators on cast-in-place concrete equipment bases.
2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

C. Install packaged engine-generator to provide access, without removing connections or accessories, for periodic maintenance.

D. Secure sets to anchor bolts installed in concrete bases.

E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

F. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.

G. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

H. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer’s instructions and seismic requirements of the site.

I. Equipment shall be initially started and operated by representatives of the manufacturer. All protective settings shall be adjusted as instructed by the consulting engineer.

J. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

K. On completion of the installation by the electrical contractor, the generator set supplier shall conduct a site evaluation to verify that the equipment is installed per manufacturer’s recommended practice

3.4 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90 degree bend in flexible conduit routed to the generator set from a stationary element.

C. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.5 IDENTIFICATION

A. Identify system components according to Section 260553 "Identification for Electrical Systems."

B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in the first two subparagraphs as specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.

a. Visual and Mechanical Inspection

1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Inspect anchorage, alignment, and grounding.
4) Verify the unit is clean.

b. Electrical and Mechanical Tests

1) Perform insulation-resistance tests in accordance with IEEE 43.

a) Machines larger than 200 horsepower (150 kilowatts). Test duration shall be 10 minutes. Calculate polarization index.
b) Machines 200 horsepower (150 kilowatts) or less. Test duration shall be one minute. Calculate the dielectric-absorption ratio.

2) Test protective relay devices.
3) Verify phase rotation, phasing, and synchronized operation as required by the application.
4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
5) Conduct performance test in accordance with NFPA 110.
6) Verify correct functioning of the governor and regulator.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.

3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
c. Verify acceptance of charge for each element of the battery after discharge.
d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and retest as specified above.

I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

K. The complete installation shall be tested to verify compliance with the performance requirements of this specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests. The generator set manufacturer shall provide a site test specification covering the entire system. Tests shall include:

L. Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.

M. Installation acceptance tests to be conducted on site shall include a "cold start" test, a two hour full load (resistive) test, and a one-step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.

N. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

B. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner

3.8 MAINTENANCE SERVICE AGREEMENT:

A. The supplier shall include in the base price, a one-year service agreement. The maintenance shall be performed by factory authorized service technicians capable of servicing both the engine-generator set and the transfer switch (es).

B. Generator supplier must have an in-house rental fleet with equipment sized to back up this project site.

C. All engine maintenance as recommended by the service manual.

D. All electrical controls maintenance and calibrations as recommended by the manufacturer.

E. All auxiliary equipment as a part of the emergency systems.

F. The supplier shall guarantee emergency service.

G. All expendable maintenance items are to be included in this agreement.

H. A copy of this agreement and a schedule shall be given to the Owner at the time of his acceptance, showing what work is to be accomplished and when.

I. The generator set supplier shall maintain service parts inventory for the entire power system at a central location which is accessible to the service location 24 hours per day, 365 days per year. The inventory shall have a commercial value of $3 million or more. The manufacturer of the generator set shall maintain a central parts inventory to support the supplier, covering all the major components of the power system, including engines, alternators, control systems, paralleling electronics, and power transfer equipment.

J. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical power system replacement parts in the local service location. Service vehicles shall be stocked with critical replacement parts. The service organization shall be on call 24 hours per day, 365 days per year. The service organization shall be physically located within 100 of the site.

K. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

END OF SECTION 263213

SECTION 263214 – ENGINE-GENERATOR LOAD TEST BANK

PART 1 - GENERAL

1.1 Related Documents:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section Includes:
1. Permanently mounted, freestanding engine-generator load test bank rated for 50kW at unity power factor with an outdoor enclosure and integral controls.

1.2 REFERENCES

A. General:
1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
3. Refer to Division 01 Section "General Requirements" for the list of applicable regulatory requirements.

B. ANSI/NFPA 70 - National Electrical Code.

C. ASTM International.

D. NEMA – National Electrical Manufacturers Association:
1. NEMA MG 1 Standard for Motors and Generators
2. NEMA WC 5 Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
3. NEMA AB 1 Molded Case Circuit Breakers.
4. NEMA ICS2 Industrial Controls and Systems: Controllers, Contactors and Overload Relays Rated 600 Volts

E. NETA – National Electrical Testing Association:
1. "Acceptance testing Specifications for Electrical Power Distribution and Equipment and Systems".

F. NFPA – National Fire Protection Association:
1. NFPA 70 - National Electrical Code (NEC) - 2002.
2. NFPA 110 “Emergency and Standby Power Systems”.

G. UL – Underwriters' Laboratories:
1. UL 508 A Industrial Control Equipment.

1.3 SUBMITTALS

A. Submit catalogue cuts with bids for items proposed to be furnished and installed under this Section.

B. Submit shop drawings to show physical arrangements, connections, finishes, provisions for connections, access requirements for installation and maintenance, physical size, mechanical and electrical characteristics and ratings, foundation and support details, and equipment weights, where such details are not indicated on the catalogue cuts. Within twenty (20) days after the Award of Order, the vendor shall submit five (5) sets of complete shop drawings and product data along for review and approval. Provide specific data on the following:
   1. Outline drawings showing overall assembly and drawings illustrating arrangement (plan, front, and side views) and lifting provisions.
   2. Certified outline plans, general arrangement (setting plan), and anchor bolt details. Drawings shall show the total weight and center of gravity of the load test bank.
   3. Arrangement, size, and location of electrical interface points and detailed elementary, schematic, wiring, and interconnection diagrams of the load test bank.
   4. Load test bank control panel.

C. Maintenance Manuals: Submittals shall include, but not be limited to, five (5) copies of the items listed below. In addition, the vendor shall include additional procedures judged necessary by the manufacturer to insure the maximum performance and service reliability for the load test bank.
   1. The load test bank shop manual(s) including complete service instructions.
   2. Parts list with the manufacturer's or interchangeable part number.
   3. Drawings of the load test bank with center of gravity clearly indicated.
   4. Schematic and wiring diagrams of power and control circuits for the load test bank and its appliances and options.

1.4 QUALITY ASSURANCE

A. Electrical equipment and materials shall be new and within one year of manufacture, complying with the latest codes and standards. No used, re-built, refurbished and/or re-manufactured electrical equipment and materials shall be furnished on this project.

B. Manufacturer's Representative: As part of the quotation, furnish the pricing for one day’s services of a qualified field engineer, experienced in the installation and operation of the type of system being provided, to inspect, test and adjust the system and to provide training for owner’s personnel.

C. Manufacturer's Responsibility: The load test bank shall be manufactured by a single manufacturer who has been regularly engaged in the production of load test banks for a minimum of 10 years. The load test bank described herein shall be factory built, factory-tested at rated load, and shipped by this single manufacturer, so there is one source of supply and responsibility for guarantee, parts, and service. This manufacturer shall have a local representative can provide factory-trained servicemen, required stock of replacement parts, and technical assistance.

D. The responsibility for performance to this Section in its entirety shall not be split up among individual suppliers of components comprising the system, but shall be assumed solely by the load test bank manufacturer. Controls shall be the standard of the load test bank manufacturer. Control parts shall be identified by parts numbers of this manufacturer and shall have second source listing where applicable. Control systems that are supplied by a vendor and not incorporated within the documentation drawings of the load test bank manufacturer are not acceptable.

E. Manufacturer's Qualifications: Company with ten years minimum experience in manufacturing the products specified in this Section.

F. Primes, Sub or Sub-sub contractors performing electrical construction work shall have C-10 Electrical Construction License from the State of California, USA with at least three years of construction experience in the similar type of projects as specified in attached construction documents and specifications.

1.5 EXTRA MATERIALS

A. As a separate quote, the bidders shall submit a recommended spare parts list with prices for one year of operation, assuming a total run time of 100 hours. The price list shall be valid for 90 days from the date of the equipment delivery.

1.6 WARRANTY

A. The manufacturer shall provide load test bank warranty for a minimum of 1 year from the date of commissioning against defects in material, equipment and workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Simplex – Vector – Radiator Airflow Cooled, Vertical Flow, Top Mount (Basis of Design)

2.2 LOAD TEST BANK

A. The load test bank shall be rated 50 kW, 60 hertz, 208 Volts, three-phase, four-wire.

B. The load test bank shall be furnished as a complete system with necessary controls and devices for manual control with automatic load dump on loss of utility power. Load bank shall be equipped for automatic operation (auto load leveling), i.e., shall maintain a minimum 30% load while the generator is in operation.

C. Load Step Resolution: The load shall be able to be stepped in a minimum of 5 steps. Tolerance: ±5 percent overall tolerance, ±2 percent phase-to-phase balance.

D. Load resistors shall be fabricated of a corrosion resistant chromium alloy with a minimum operating temperature of 1900 deg F (1038 deg C). Resistors shall be continuously supported to eliminate possible shorting contact with surrounding resistors.

E. Cooling: Forced-air cooled. Cooling fan motor to derive power from the test source. Provide temperature and air flow sensors to initiate load removal if airflow is insufficient for proper cooling.

F. Control Power supplied to the load bank shall be obtained from an external source.

G. The load bank shall be costumed designed to fit the specific outlet of the generator.

H. Simplex Vector load banks are horizontally oriented duct mounted load banks intended for use with enclosed generator sets. The load bank is to be mounted horizontally above the genset's vertical exhaust outlet and will use the genset's radiator fan outflow as its cooling air.

I. Overload and overcurrent protection shall be provided for each individual load section and control circuit.

J. Duty Cycle: Continuous Ambient temp: 125°F

K. The load bank is a completely self-contained, freestanding unit which includes all resistive load elements, load control devices, load element branch circuit fuse protection, main load bus and terminals, cooling system, control power supply, digital controller with malfunction detection system. Outdoor type enclosure.

L. Load elements: Simplex Power Web: UL/CUL Recognized component. Open wire, helically wound, chromium alloy, thermally derated to 60%. 5% tolerance, 2% balance. 0.995 power factor. Element wire mechanically supported over entire length such that if a wire should break, the broken wire segments will not short to adjacent conductors or to ground. Load elements individually serviceable and replaceable in the field without major disassembly of load bank. Load elements installed in slide-out, removable trays such that any element is easily accessed without disturbing any other elements. All materials used in the mounting and installation of the load elements are suitable for the temperatures encountered, in both normal operation and under fault conditions. Materials in direct contact with the element wire are ceramic. Other materials which structurally support the load elements and/or which form the hot air duct within which the elements are mounted are steel, stainless steel or aluminum.

M. Element circuit protection: Branch circuit fuses, each 50kw branch circuit maximum, 200kAIC, 600v, current limiting type.

N. Power Wiring: 150°C insulated; color-coded and numbered.

O. Control Wiring: 105°C insulated, color-coded and numbered

P. Power connection: Plated bus bar within Type 3R terminal junction box to accept terminated contractor/field cables

Q. Control connection: Plated bus bar within Type 3R terminal junction box to accept terminated contractor/field cables.

R. System protection: Fan failure, high exhaust temp, hi intake temp, fan motor overload; lockout and alarm message display on HMI. Airflow pressure differential switch; dual exhaust temperature thermocouples; intake air temperature thermocouple; fan motor overload relay. Display of temperatures on HMI.

S. Enclosure: Type 3R control section. Hinged access doors with lockable latches. Power section double-wall construction for thermal isolation Vertical airflow, top exhaust. Screened inlets/exhaust. Rain shedding vanes within exhaust hood. Forklift channels, lifting eyes. Powder coated dark gray cabinet, high temperature black exhaust hood. UL/CUL Listed process.

T. Digital Controller: PLC based with 6-inch color TFT touchscreen with programmable softkeys (HMI) Local or remote control (specify one) When local, installed behind weatherproof cover. When remote, installed in type-3R wall mountable enclosure. Capable of multi-remote station control. Capable of limited user programming for time/load sequencing.

U. Powder coated finish to match genset.
Includes:
1. Power supply for PLC / screen, 24vDC
2. Malfunction detection/auto disconnect system. Monitors airflow pressure differential switch, temperature sensing thermocouples and fan motor overload relay. Display air temperatures

on screens. Allows operator programming of temperature set points. Allows for failure sensing time delays. Displays alarm messages. Provides remote MODBUS registers and remote alarm contacts.

3. Remote load dump circuit to allow use of remote dry contacts (close to run) to trip load bank off line.
4. Remote communications modules, MODBUS RTU/RS-485 (std), MODBUS RTU/TCIP (Ethernet) (Optional)
5. Auxiliary dry contacts to indicate "normal operation"/"system failure"
6. HMI functions, including:
   a. Control Power On – Off buttons (starts/stops cooling fan)
   b. Bypass switch to override remote load dump
   c. Direct entry load application: keypad to enter direct values, apply and remove pushbuttons. Displays load programmed and load applied. Allows direct transition from preset to preset.
8. HMI messages including (repeated as MODBUS registers):
   a. Control Power On/Off
   b. Manual mode
   c. Auto mode (if equipped)
   d. Load dump: normal/bypass
   e. Normal operation
   f. High exhaust temp with numeric display
   g. High intake temp with numeric display
   h. Airflow failure
   i. Fan motor overload
   j. Master load on
   k. Load step on (one for each load step)

V. Load bank – automatic operation: digital transducer and current transformers to capture electrical values. Type load bank shall provide the following capability:
Display of electrical values on touchscreen: 3-phase voltage, 3-phase amperes, frequency, KW
MODBUS registers for these values -Programmable automatic operation:

- KW sensing automatic load regulation and minimum loading
- KW sensing regenerative power protection –
- Automatic sequential step loading
- Automatic exercise (requires external control power)
- Other programmable automatic functions
- Operator programmable levels, delays, time sequencing.

Additional protective features, user activated, user programmable:

- Over/under voltage
- Over/under current
- Over/under frequency
- Over/under power (KW)

2.3 REMOTE CONTROL PANEL

A. A remote-control panel with a NEMA 4 enclosure shall be provided for installation near the load bank. Devices mounted on the control panel shall be approved for outdoor installation.

B. The remote-control panel shall be furnished with:
   1. Control Mode Selector Switch (Manual-Off-Automatic).
   2. Fan Control/Failure Reset Switch (Off-Fan On-Reset)
   3. Master Load Switch (Off-On)
   4. Load Step Switches (off-On)

5. Fan Running Indication Light (Green)
6. Cooling Failure Light (Red)
7. Load Step Indication Lights (Blue)

2.4 WIRING

A. Internal wiring for the load test bank and control panel shall be stranded copper conductor, No. 14 AWG minimum, with 600 Volt insulation suitable for the application. Wiring to external points shall be brought to a common terminal block.

2.5 ENCLOSURE

A. Outdoor Weatherproof Enclosure: The enclosure shall be rated NEMA 3R and be of galvanized steel construction with bolt down provisions for permanent mounting. Exhaust and intake louvers shall be screened for debris protection and shall be fabricated from stainless steel.

B. Painting: powder coated to match genset.

2.6 MAINTENANCE REQUIREMENTS

A. All replaceable parts shall be manufactured to definite standards for tolerance, clearance, and finish in order that such part may be field installed without further machining or fitting. Parts shall be permanently and legibly marked with the original manufacturer's part number where practical. Parts or assemblies that require "fitting" for proper assembly shall be identified and separately listed in the parts manual.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Contractor will inform the client when the load test bank installation is completed. If required by the owner, an authorized representative of the manufacturer shall inspect the installation and shall perform the installation acceptance testing. The owner’s authorized representative will be present for the installation inspection and acceptance testing.

3.2 OPERATION AND MAINTENANCE TRAINING

A. If required by the owner, operating personnel shall be instructed by the vendor or manufacturer's representative in the proper operation and maintenance of the unit on the test day.

3.3 FINAL SUBMITTALS

A. Five (5) sets of bound copies of text and illustrations, delineating maintenance and repair procedures. Assemble data on like equipment in clearly identified and indexed three-ring binders or equal. Include the following:
1. Parts list of replaceable parts and special tools required.

2. Lists of component items not the product of the manufacturer of equipment on which used, with local source of supply, catalog cuts, and necessary information for ordering replacements.
3. Complete as-built electrical schematic and connection diagrams with internal and external connection points identified to match identification on equipment.
4. Test Reports: Submit certified test and inspection reports for work performed in Paragraph 3.1.

B. Furnish a written Guarantee that the equipment will meet the specified performance. In addition, the guarantee shall cover the equipment against defects in design, workmanship and material for one (1) year from date of start-up.

END OF SECTION 263214

SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches.
2. Remote annunciation systems.
3. Remote annunciation and control systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

1. The transfer switch shall be serviced by technicians employed by, and specially trained and certified by, the generator set supplier and the supplier shall have a service organization that is factory-certified in both generator set and transfer switch service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

2. Submit names, experience level, training certifications, and locations for technicians that will be responsible for servicing equipment at this site.
3. The manufacturer shall maintain model and serial number records of each transfer switch provided for at least 20 years.

B. Source Limitations: All transfer switches are to be obtained through one source from a single manufacturer. The generator set manufacturer shall warrant transfer switches to provide a single source of responsibility for products provided.

C. Electrical Components, Devices, and Accessories: UL Listed and labeled per UL standard 1008 as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked as suitable for use in emergency, legally required or optional standby use as appropriate for the connected load.

D. Comply with NEMA ICS 1.

E. Comply with NFPA 70.

F. Comply with NFPA 110. Emergency and Standby Power Systems. The transfer switch shall meet all requirements for Level 1 systems, regardless of the actual circuit level

G. Comply with UL 1008 unless requirements of these Specifications are stricter.

H. The manufacturer shall warrant the material and workmanship of the transfer switch equipment for a minimum of one (1) year from registered commissioning and start-up, or eighteen (18) months from date of shipment.

I. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, and etc. during the minimum noted warranty period described above.

J. The transfer switch equipment shall be designed, built, tested, furnished, and warranted by the manufacturer of the generator set to ensure one source of responsibility for the complete emergency standby power system. Transfer switch shall be warranted by the generator set supplier for five years from the date of start up for parts and labor, without a deductible. Transfer switches shall be Cummins model OTPCSE or Equivalent Asco 700 series And Russ electric RMT series only.

K. The ATS shall have the proper overcurrent protection equipment on the utility side of the switch.

L. Transfer switches shall be rated to carry 100 percent of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C, relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000M).

M. Transfer switch equipment shall have withstand and closing ratings (WCR) in RMS symmetrical amperes greater than the available fault currents shown on the drawings. The transfer switch and its upstream protection shall be coordinated. The transfer switch shall be third party listed and labeled for use with the specific protective device(s) installed in the application.

ATS’s shall be provided with a switched neutral pole. The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar. Equipment using add-on accessory overlapping contacts are not acceptable

1.6 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:

1. Notify Engineer and Owner fewer than ten days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Engineer's and Owner's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Contactor Transfer Switches:

1. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:

a. Cummins Power Generation (Basis-of Design)
b. Russelectric
c. ASCO

B. Equipment specifications for this Project are based on automatic transfer switches manufactured by Cummins Power Generation. Switches manufactured by Russelectric or ASCO that meet the requirement of this specification are acceptable, if approved not less than two weeks before scheduled bid date. Proposals must include a line-by-line compliance statement based on this specification.

C. Transfer switches utilizing molded case circuit breakers do not meet the requirements of this specification and will not be accepted.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

B. Provide transfer switches in the number and ratings that are shown on the drawings. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer.

C. Fault-Current Closing and Withstand Ratings: UL 1008 WCR ratings must be specifically listed as meeting the requirements for use with protective devices at installation locations, under specified fault conditions. Withstand and closing ratings shall be based on use of the same set of contacts for the withstand test and the closing test.

D. Solid-State Controls: All settings should be accurate to +/- 2% or better over an operating temperature range of - 40 to + 60 degrees C (- 40 to + 140 degrees F).

E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

F. Electrical Operation: Accomplished by a non-fused, momentarily energized solenoid or electric motor operator mechanism, mechanically and electrically interlocked in both directions (except that mechanical interlock is not required for closed transition switches).

G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Switches using molded-case switches or circuit breakers, or insulated case circuit breaker components are not acceptable.
2. Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in the Source 1 and Source 2 positions.
3. Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.
4. Contacts shall be operated by a high-speed electrical mechanism that causes contacts to open or close within three electrical cycles from signal.
5. The transfer switch operation shall include the ability to switch to an open position (both sources disconnected) for the purpose of load shedding from the generator set.
6. The power transfer mechanism shall include provisions for manual operation under load with the enclosure door closed. Manual operation may be electromechanical or mechanical, but must be coordinated with control function.
7. Transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation but prevent direct contact with components that could be operating at line voltage levels.
8. The transfer switch shall include the mechanical and control provisions necessary to allow the device to be field-configured for operating speed. Transfer switch operation with motor loads shall be as is recommended in NEMA MG1.
    a. Phase angle monitoring/timing equipment is not an acceptable substitute for this functionality
9. Transfer switches designated on the drawings as “4-pole” shall be provided with a switched neutral pole switched which is switched simultaneously with phase poles..
10. Transfer switches designated on the drawings as “3-pole” shall have a full current-rated neutral bar with lugs.

H. Control: Transfer switch control shall be capable of communicating with the genset control, other switches and remote programming devices over a high-speed network interface.

I. Enclosures: All enclosures shall be third-party certified for compliance to NEMA ICS 6 and UL 508, unless otherwise indicated:

1. The enclosure shall provide wire bend space in compliance to the latest version of NFPA70, regardless of the direction from which the conduit enters the enclosure.
2. Exterior cabinet doors shall provide complete protection for the system’s internal components. Doors must have permanently mounted key-type latches. Bolted covers or doors are not acceptable.
3. Transfer switches shall be provided in enclosures that are third party certified for their intended environment per NEMA requirements.
    a. Transfer switches mounted in a controlled indoor environment shall be provided in NEMA Type 1 enclosures (IEC type IP30).
    b. Transfer switches installed indoors shall be NEMA Type 12 (IEC type IP61) if the Project environment requires dust-proof and/or drip-proof equipment.
    c. Transfer switches located outdoors shall be supplied in NEMA Type 3R (IEC IP34) when dust-proof and/or rain-proof enclosures are required.
    d. Transfer switches that are installed outdoors or in any other uncontrolled environment shall be supplied with NEMA Type 4 or 4X (stainless steel) enclosures (IEC IP65

J. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

K. Transfer switches shall be double-throw construction, positively electrically and mechanically interlocked by mechanical beam to prevent simultaneous closing (for break before make operation), and mechanically held in both normal and emergency positions.

L. Transfer switch shall be equipped with permanently attached operating handles and quick-break, quick-make contact mechanisms suitable for manual operation under load.

M. Main switch contacts shall be high pressure silver alloy contacts to resist burning and pitting for long life operation. Contact assemblies shall have arc chutes of heat absorbing material and metal leaves for positive extinguishing of arcs. Arc chutes shall have insulating covers to prevent interphase flashover.

N. Transfer switches shall have one form C, 10 amp, 250 volt, AC auxiliary switch on both normal and emergency sides, operated by the transfer switch.

O. Terminal lugs, UL listed and CSA approved, as suitable for copper and aluminum conductors shall be provided for normal, emergency, and load connections. Wire bend space shall comply with NEC Article 373.

P. Manual operating handles and all control switches (other than key operated switches) shall be accessible to authorized personnel only by opening the key locking cabinet door. Transfer switches with manual operating handles and/or non key-operated control switches located on outside of compartment do not meet this specification and are not acceptable.

Q. Transfer switch equipment shall have withstand and closing ratings (WCR) in RMS symmetrical amperes greater than the available fault currents shown on the drawings. The transfer switch and its upstream protection shall be coordinated. The transfer switch shall be third party listed and labeled for use with the specific protective device(s) installed in the application. At a minimum the automatic transfer switch ratings shall be as follows:

R.

AMPS	Withstand with Molded case CB	Withstand with Fuses
40-125	14,000	200,000
150-260	30,000	200,000
300-600	65,000	200,000
800-1000	65,000	200,000
1200	85,000	200,000
1600-2000	100,000	200,000
3000	100,000	200,000

S. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-

coding and wire and cable tape markers are specified in Section 260553 "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Indicated current ratings:

1. Refer to the Project drawings for specifications on the sizes and types of transfer switch equipment, withstand and closing ratings, number of poles, voltage and ampere ratings, enclosure type, and accessories.
2. Main contacts shall be rated for 600 VAC minimum.
3. Transfer switches shall be rated to carry 100% of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C (-40 to +140 degrees F), relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000 meters).

C. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

D. The transfer switch physically located closest to the generator and not more than 50 ft (15 meters) away, except those served by generator paralleling equipment, shall be provided with a battery charger suitable for the requirements of the application and in compliance with NFPA 110 requirements for Level 1 systems. If no transfer switch is located within this distance, a battery charger shall be installed on the generator set.

E. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

F. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

1. Power source serving load initiates automatic break-before-make transfer.

G. Automatic Transfer-Switch Control Features:

1. The transfer switch control system shall be configurable in the field for any operating voltage level up to 600 VAC. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions that are not field configurable are not acceptable.
2. All transfer switch sensing shall be configurable from an operator panel or from a Windows XP or later PC-based service tool. Designs utilizing DIP switches or other electromechanical devices are not acceptable.
3. The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device for load shedding purposes. On receipt of this signal, the transfer switch shall switch to a neutral position when connected to Source 2. If Source 1

is available when the load-shed signal is received, the transfer switch shall connect to Source 1.

4. The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device to prevent transfer to the generator service.
5. The transfer switch shall provide a relay contact signal prior to transfer or re-transfer. The time period before and after transfer shall be adjustable in a range of 0 to 50 seconds.
6. The control system shall be designed and prototype tested for operation in ambient temperatures from - 40 degrees C to + 60 degrees C (- 40 to +140 degrees F). It shall be designed and tested to comply with the requirements of the noted voltage and RFI/EMI standards.
7. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.
8. The transfer switch network monitoring equipment, when supplied, shall be provided with a battery-based auxiliary power supply to allow monitoring of the transfer switch when both AC power sources are non-operational. The battery power supply shall be monitored for proper condition, and the transfer switch shall include an alarm condition to indicate low battery condition.

H. Transfer Switch Control Panel: The transfer switch shall have a microprocessor-based control with a sealed membrane panel incorporating pushbuttons for operator-controlled functions, and LED lamps for system status indicators. The panel shall also include an alphanumeric display for detailed system information. Panel display and indicating lamps shall include permanent labels.

1. The indicator panel LEDs shall display:

   a. Which source the load is connected to (Source 1 or Source 2)
   b. Which source or sources are available
   c. When switch is not set for automatic operation, because the control is disabled or the bypass switch is in use
   d. When the switch is in test/exercise mode

2. The indicator shall have pushbuttons that allow the operator to activate the following functions:

   a. Activate pre-programmed test sequence
   b. Override programmed delays, and immediately go to the next operation
   c. Reset the control by clearing any faults
   d. Test all of the LEDs by lighting them simultaneously

3. The alphanumeric digital display shall be vacuum fluorescent-type, clearly visible in both bright sunlight and no-light conditions over an angle of 120 degrees, and shall display the following:

   a. AC voltage for all phases, normal and emergency
   b. Source status: connected or not connected.
   c. Load data, including voltage, AC current, frequency, KW, KVA, and power factor.

4. The display panel shall be password-protected, and allow the operator to view and make adjustments:

   a. Set nominal voltage and frequency for the transfer switch
   b. Adjust voltage and frequency sensor operation set points

c. Set up time clock functions
d. Set up load sequence functions
e. Enable or disable control functions including program transition
f. View real-time clock data, operation log (hours connected, times transferred, failures) and service history

I. Control Functions: Functions managed by the control shall include:

1. Software adjustable time delays:

a. Engine start (prevents nuisance genset starts in the event of momentary power fluctuation): 0 to 120 seconds (default 3 sec)
b. Transfer normal to emergency (allows genset to stabilize before load is transferred): 0 to 120 seconds (default 3 sec)
c. Re-transfer emergency to normal (allows utility to stabilize before load is transferred from genset): 0 to 30 minutes (default 3 sec)
d. Engine cooldown: 0 to 30 minutes (default 10 min)
e. Programmed transition: 0 to 60 seconds (default 3 sec)

2. Undervoltage sensing: three-phase normal, three-phase emergency source.

a. Pickup: 85 to 98% of nominal voltage (default 90%)
b. Dropout: 75 to 98% of nominal voltage (default 90%)
c. Dropout time delay: 0.1 to 1.0 seconds (default 0.5 sec)
d. Accurate to within +/- 1% of nominal voltage

3. Over-voltage sensing: three-phase normal, three-phase emergency source.

a. Pickup: 95 to 99% of dropout setting (default 95%)
b. Dropout: 105 to 135% of nominal voltage (default 110%)
c. Dropout time delay: 0.5 to 120 seconds (default 3 sec)
d. Accurate to within +/- 1% of nominal voltage

4. Over/under frequency sensing:

a. Pickup: +/- 5 to +/-20% of nominal frequency (default 10%)
b. Dropout: +/-1% beyond pickup (default 1%)
c. Dropout time delay: 0.1 to 15.0 seconds (default 5 sec)
d. Accurate to within +/- 0.2%

5. Voltage imbalance sensing:

a. Dropout: 2 to 10% (default 4%)
b. Pickup: 90% of dropout
c. Time delay: 2.0 to 20 seconds (default 5 sec)

6. Phase rotation sensing:

a. Time delay: 100 msec

7. Loss of single-phase detection:

a. Time delay: 100 msec

J. Control features shall include:

1. Programmable genset exerciser: A field-programmable control shall periodically start the generator, transfer the load to generator for a preset time, then re-transfer and shut down the generator after a preset cool-down period.

    a. Push-button programming control shall have a selection of eight different schedules for exercising generator, with or without load.

2. In event of a loss of power to the control, all control settings, real-time clock setting and the engine start-time delay setting will be retained.
3. The system continuously logs information including the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. An event recorder stores information, including time and date-stamp, for up to 50 events.
4. Transfer Override Switch: Overrides automatic re-transfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light to indicate override status.

K. Control Interface

1. Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.
2. The transfer switch shall be provided with a network communication card, and configured to allow network-based communication with the transfer switch and other network system components, including the generator set(s) provided for the Project.
3. Unassigned Auxiliary Contacts: Two normally open, 1-pole, double-throw contacts for each switch position, rated 10A at 240 VAC.

L. Engine Starting Contacts

1. One isolated and normally closed, and one isolated and normally open; rated 10A at 32 VDC minimum.

2.4 REMOTE ANNUNCIATOR SYSTEM

A. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:

1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
2. Switch position.
3. Switch in test mode.
4. Failure of communication link.

B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

1. Indicating Lights: Grouped for each transfer switch monitored.
2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
4. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.5 REMOTE ANNUNCIATOR AND CONTROL SYSTEM

A. Functional Description: Include the following functions for indicated transfer switches:

1. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
2. Indication of switch position.
3. Indication of switch in test mode.
4. Indication of failure of digital communication link.
5. Key-switch or user-code access to control functions of panel.
6. Control of switch-test initiation.

B. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically reverts to stand-alone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.

1. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.

2.6 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Design each fastener and support to carry load.

B. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

C. Identify components according to Section 260553 "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.3 FIELD QUALITY CONTROL

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

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

F. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. After generator set installation, the generator and transfer switch supplier shall conduct a complete operation, basic maintenance, and emergency service seminar covering generator set and transfer switch equipment, for up to 10 people employed by the Owner.

1. The seminar shall include instruction on operation of the transfer equipment, normal testing and exercise, adjustments to the control system, use of the PC based service and maintenance tools provided under this contract, and emergency operation procedures.
2. The class duration shall be at least 8 hours in length, and include practical operation with the installed equipment.

3.5 ON SITE ACCEPTANCE TEST

A. The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by contractor. Installation acceptance tests to be conducted on-site shall include a “cold start” test and accept 100% block load within 10 seconds per NFPA 110, a two hour full load test utilizing a resistive loadbank. Contractor is responsible for temporary disconnecting the power feeders from the generator, connecting the loadbank testing cables and restoring the power feeders at the completion of the test. Provide a one-step connected load pickup test.

3.6 SERVICE AND SUPPORT

A. The manufacturer shall supply the Owner with a complete set of the service and maintenance software required to support the product. The software shall be provided at a training class attended by the user, to qualify the user in proper use of the software. The software shall have the following features and capabilities:

1. The software shall be 32 bit and shall be XP and Vista compatible.
2. The software shall use the Windows Explorer format, for ease of use and commonality with other software in use at the facility.
3. The software shall allow adjustment of all functions described herein, adjustment of operating levels of all protective functions, and programming of all optional functions in the controller. Adjustments shall be possible over modem from a facility that is remote from the generator set.
4. The software shall be capable of storing and displaying data for any function monitored by the generator set control. This data shall be available in common file formats, and on graphical “strip chart” displays.
5. The software shall automatically record all control operations and adjustments performed by any operator or software user, for tracking of changes to the control.
6. The software shall display all warning, shutdown, and status changes programmed into transfer switch controller. For each event, the control shall provide information on the nature of the event, when it last occurred, and how many times it has occurred.

END OF SECTION 263600

SECTION 265100 – LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Interior luminaires.
2. Emergency lighting units.
3. Exit signs.
4. Luminaires supports.

B. Related Sections:

1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. BF: Ballast factor.

B. CCT: Correlated color temperature

C. CRI: Color-rendering index.

D. CU: Coefficient of utilization

E. LER: Luminaire efficacy rating.

F. Luminaire: Complete lighting fixture, including ballast housing if provided.

G. RCR: Room cavity ratio.

1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. Driver and diodes factor.
4. Energy-efficiency data.

5. Life, output, CCT, CRI, lumens and energy-efficiency data for luminaires.
6. Photometric data, in IESNA format, based on laboratory tests of each luminaire type, outfitted with accessories identical to those indicated for the luminaires as applied in this Project. Provide conversion factors for all luminaire data if not the same as supplied for this project.

B. Shop Drawings: For nonstandard or custom luminaires.Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring.

C. Coordination Drawings: Reflected ceiling plan(s), drawn to scale, on which luminaires, suspension system, construction that penetrates ceilings or is supported by them and other details are shown. Coordinate the following items, as a minimum, with each other, using input from Installers of the items involved:

1. Lighting fixtures.
2. Suspended ceiling components.
3. Structural members to which suspension systems for lighting fixtures will be attached.
4. Other items in finished ceiling including the following:

    a. Air outlets and inlets.
    b. Speakers.
    c. Sprinklers.
    d. Smoke and fire detectors.
    e. Occupancy sensors.
    f. Access panels.
    g. Ceiling mounted projectors
    h. Partitions and millwork that penetrate the ceiling or extends to within one foot of the plane of the luminaires.

5. Perimeter moldings.

D. Product Certificates: For each type of ballast for dimmer-controlled fixtures, from manufacturer.

E. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

F. Field quality-control reports.

G. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

H. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

D. Provide specified manufacturer or approved substitute manufacturer listed in Fixture Schedule.

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies. Coordinate the following items, as a minimum, with each other, using input from Installers of the items involved:

1. Lighting fixtures.
2. Suspended ceiling components.
3. Structural members to which suspension systems for lighting fixtures will be attached.
4. Other items in finished ceiling including the following:

    a. Air outlets and inlets.
    b. Speakers.
    c. Sprinklers.
    d. Smoke and fire detectors.
    e. Occupancy sensors.
    f. Access panels.
    g. Ceiling mounted projectors
    h. Partitions and millwork that penetrate the ceiling or extends to within one foot of the plane of the luminaires.

1.7 WARRANTY

A. Special Warranty for Emergency Lumiaires Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
2. Completion.

B. Special Warranty for LED: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: Ten year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In the Luminaire Schedule where titles below are column or row headings that introduce lists or are added in notes for particular luminaire types, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
2. Basis-of-Design Product: The design for each luminaire is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by another manufacturer equal to the specified. Provide manufacturers data sheets and point-to point calculations for the substituted luminaires.

2.2 LUMINAIRES,, GENERAL REQUIREMENTS

A. Recessed Luminaires: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

1. Aluminum or steel housing; finish.as per luminaire schedule on plans

B. LED Luminaires: Comply with UL 1598. .

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally when secured in operating position.

F. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.

G. Diffusers and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless different thickness is indicated.
b. UV stabilized.

2. Glass: Annealed crystal glass, unless otherwise indicated.

2.3 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

    a. Battery: Sealed, maintenance-free, nickel-cadmium type.
    b. Charger: Fully automatic, solid-state type with sealed transfer relay.
    c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
    d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
    f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

2.4 EMERGENCY LED BATTERY UNITS

A. Description: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Integral Time-Delay Relay: Holds unit on for fixed interval of 10 minutes when power is restored after an outage.
7. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

PART 3 - PRODUCTS

3.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**

3.2 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Recessed Fixtures: Comply with NEMA LE 4.

C. CRI of minimum 80 ; CCT of 3500 K

D. Rated lamp life of minimum **50,000** hours.

E. LED dimmable from 100 percent to 0 percent of maximum light output.

F. Internal driver.

G. Nominal Operating Voltage – see Luminaire Schedule on plans.

H. Housings:

PART 4 - EXECUTION

4.1 INSTALLATION

A. Luminaires: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Luminaires in or on Grid-Type Suspended Ceilings: Use grid as a support element.

1. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
2. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
3. Install at least two independent support rods or wires from structure to a tab on lighting fixture. Wires or rods shall have breaking strength of the weight of fixture at a safety factor of 3.

C. Suspended Luminaires Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

3. Do not use grid as support for pendant luminaires. Provide support wires or rods connected to building structure.

D. Adjust aimable luminaires to provide required light intensities.

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

4.2 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265100

SECTION 265119 – LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior solid-state luminaires that use LED technology.
2. Lighting fixture supports.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, arranged by designation.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale and coordinated with each other, using input from installers of the items involved:

B. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.

C. Product Certificates: For each type of luminaire.

D. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Minimum Ten year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**

2.2 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. Recessed Fixtures: Comply with NEMA LE 4.

E. CRI of minimum 80 ; CCT of 3500 K

F. Rated lamp life of minimum **50,000** hours.

G. Lamps dimmable from 100 percent to 0 percent of maximum light output.

H. Internal driver.

I. Nominal Operating Voltage – see Luminaire Schedule on plans.

J. Housings:

1. Aluminum or steel housing; finish.as per luminaire schedule on plans

2.3 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Division 26 for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, as per manufacturer's specifications.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Aircraft cable shall be 1/8 inch.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports: Sized and rated for luminaire weight.

E. Flush-Mounted Luminaire Support: Secured to outlet box.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

G. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with two minimum 5/32-inch diameter aircraft cable supports adjustable to 36 inches.

H. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.

2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.

3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and **wire support** for suspension for each unit length of luminaire chassis, including one at each end.

4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

I. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire using approved fasteners in a minimum of four locations, spaced near corners of luminaire.

J. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26.

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 265119

SECTION 265600 – EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Exterior solid-state luminaires that use LED technology.
   2. Luminaire-mounted photoelectric relays.

1.2 ACTION SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, and finishes.

B. Shop Drawings: Anchor-bolt templates keyed to specific poles and certified by manufacturer.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2, "National Electrical Safety Code."

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Lithonia WST LED or approved equal.

2.2 GENERAL DESCRIPTION: A die-cast LED trapezoidal wall sconce with a non-pixilated light source for visual comfort. The lumen output of up to 6,500 lumens and an efficacy greater than 120 LPW. When required by Code, the luminaire must be available with two individual drivers paired with two independent light engines which provide the required redundancy.

A. Construction: The single-piece die-cast aluminum housing integrates secondary heat sinks to optimize thermal transfer from the internal light engine heat sinks and promote long life. The driver is mounted in direct contact with the casting for a low operating temperature and long life. The die-cast door frame is fully gasket with a one-piece solid silicone gasket to keep out moisture and dust, providing an IP65 rating for the luminaire.

B. Finish: Exterior parts are protected by a zinc-infused Super Durable TGIC thermoset powder coat finish that provides superior resistance to corrosion and weathering. A tightly controlled multi-stage process ensures a minimum 3 mils thickness for a finish that can withstand extreme climate changes without cracking or peeling. Standard Super Durable colors include dark bronze, black, natural aluminum, sandstone, and white. Available in textured and non-textured finishes.

C. Optics: Well-crafted reflector optics allow the light engine to be recessed within the luminaire, providing visual comfort, superior distribution, uniformity, and spacing in wall-mount applications.

D. Electrical: Light engine(s) consist of 98 high-efficacy LEDs mounted to a metal core circuit board and integrated aluminum heat sinks to maximize heat dissipation and promote long life (100,000 hrs at 40°C, L87). Class 2 electronic driver has a power factor >90%, THD <20%. Easily serviceable surge protection device meets a minimum Category B (per ANSI/IEEE C62.41.2).

E. Installation: A universal mounting plate with integral mounting support arms allows the fixture to hinge down for easy access while making wiring connections.

F. Listings: CSA certified to U.S. and Canadian standards. The luminaire is IP65 rated. PIR and back box options are rated for wet location. Rated for -30°C to 40°C ambient. DesignLights Consortium® (DLC) Premium qualified product. Not all versions of this product may be DLC Premium qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

G. Warranty: 5-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx.

2.01 LED FIXTURES

A. LED Light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.

B. LED Light fixtures shall be Reduction of Hazardous Substances (RoHS) – compliant.

C. LED Drives shall include the following features unless otherwise indicated.

1. Minimum efficiency: 85% at full load

2. Minimum Operating Ambient Temperature: -20 degrees C. (14 degrees F.)

3. Input Voltage: 120 – 277V (+-10%) at 60 Hz.

4. Integral short circuit, open circuit, and overload protection.

5. Power Factor: less than or equal to 0.95.

6. Total Harmonic Distortion: less than or equal to 20%.

7. Comply with FCC 47 CFR Part 15.

Fixtures: For fixture types see Lighting Fixture Schedule on drawings.

2.3 NOTES

A. Actual performance may differ as a result of end-user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C. Specifications subject to change without notice.

B. Sample Nomenclature:

1. Standard: WST LED P1 40K VF MVOLT DDBTXD.
2. With Redundant Gear: WST LED P1 40K VF MVOLT **DS** DDBTXD.

C. Key Specifications:

Construction	Die-cast aluminum
Finish	zinc-infused Super Durable TGIC thermoset powder coat
Ingress Protection	IP65
Optics	Non-pixilated source, prismatic glass
Optical Performance	0% up-light and less than 20% back-light
Efficacy	>120 LPW
Lumen Maintenance	>L92 / 50,000 hours
CCT / CRI	2700K, 3000K, 4000K, 5000K; >70 CRI
Controls	Bi-level motion sensor

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicate structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming.

3.2 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 3.

3.3 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

3.01 INSTALL ON CONCRETE BASE WITH TOP 4 INCHES ABOVE FINISHED GRADE OR SURFACE AT LUMINAIRE LOCATION. CAST CONDUIT INTO BASE, AND FINISH BY TROWELING AND RUBBING SMOOTH. CONCRETE MATERIALS, INSTALLATION, AND FINISHING ARE SPECIFIED IN DIVISION 3.

3.02 FIELD QUALITY CONTROL

A. Inspect installed units for damage.

B. Provide advance notice of dates and times for field tests. Coordinate with Architect.

C. Provide instruments to make and record test results.

D. Tests: Verify normal operation of lighting units after installing fixtures and energizing circuits with normal power source. Include the following:

8. Photometric Tests: Measure light intensities at locations where specific illumination performance is indicated. Use photometers with calibration referenced to NIST standards.

9. Check for excessively noisy ballasts.

10. Check for uniformity of illuminations.

11. Written report of tests indicating actual illumination results.

E. Replace or repair damaged and malfunctioning units and retest.

3.03 ADJUSTING AND CLEANING

A. Clean components on completion of installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities.

3.4 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26. In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 GROUNDING

A. Ground metal support structures according to Division 26.

B. Ground nonmetallic support structures according to Division 26.

END OF SECTION 265600