

SECTION 26 55 61 – THEATRICAL LIGHTING AND CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes equipment for stage lighting systems, including fixtures, lamps, dimmers, controls, and distribution components.
- B. Provide product demonstration and commissioning as listed in part 3.

1.2 SUBMITTALS

- A. Product Data: For fixtures, lamps, distribution components, and control systems, including dimensions and data on features and components. Include data on ratings and features of devices.
- B. Shop Drawings: Detail dimmer racks showing arrangements, characteristics, and circuit assignments of various modules. Include elevation views of front panels indicating devices and controls. Include illustrations and dimensioned drawings.
  - 1. Wiring diagrams: Detail wiring for power and control systems and differentiate between manufacturer-installed and field-installed wiring.
- C. Manufacturer Certificates: Signed by the manufacturer certifying that they comply with requirements. Include evidence of manufacturing experience.
- D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- E. Maintenance Data: For fixtures, distribution equipment, software operating manuals, instructional videotapes, and controls are to be included in maintenance manuals specified in Division 1.
- F. Record Data: Show connections and circuit and channel assignments.

1.3 QUALITY ASSURANCE

- A. Where rigging and other accessories are attaching to equipment provided by another contractor (i.e. stage electric bars, and/or front of house lighting truss when provided), review applicable rigging specifications and shop drawings to ensure appropriate attachment equipment is included in the bid and provided to the site for installation.
- B. Installer Qualifications: An experienced installer who has installed systems of similar scope and function as the units required for this project.
- C. Manufacturer Qualifications: A firm experienced in manufacturing equipment similar to that indicated for this project that maintains technical support service available by toll-free telephone number. Service capability to provide the user with training, parts, and emergency maintenance and repairs support within 48 hours maximum response time.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

- E. Comply with NFPA 70.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but not limited to, the following:
  - 1. Electronic Theatre Controls, Inc. – Base Bid
  - 2. Lehigh Electric Products Company – Alternate Bid

### 2.2 FIXTURES AND DISTRIBUTION EQUIPMENT, GENERAL

- A. Metal Parts: Free from burrs and sharp corners and edges.
- B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support sheet metal to prevent warping and sagging.
- C. Pipe and connector strip rigging: Provide steel pipe clamps and braided steel cable, sized for the full load of pipe, connector strip, light fixtures and other accessories with industry standard safety factors. The use of chain shall not be acceptable.
- D. Fixture Doors and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without the use of tools. Arrange doors, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.
- E. Pigtail: Factory wired 36-inch (900 mm) long, 3-wire cord and plug connector assembly with cord encased in woven fiberglass or silicone tubing.
- F. Plug Connectors: Two-pole, 3-wire, 20-A twist-locking or parallel blade type as scheduled.
- G. Pipe Clamps: Malleable iron and designed for clamping fixtures to 3/4- to 2-inch (20 to 51 mm) OD pipe and equipped with a T-bolt to lock alignment. Arrange fixture clamps for horizontal rotation of yoke for aiming.
- H. Safety Cables: Heavy duty, flexible steel, 30-inch (760) nominal length, with spring clip at one end and steel ring at other.
- I. Lamp Sockets: Unless LED, which are fixed, relampable without disturbing focus adjustment or alignment.
- J. Fixture Ventilation Openings: Baffled against light leaks.
- K. Fixture Operating Controls and Handles: Thermally insulated.
- L. Lenses: Borosilicate glass in silicone mountings.
- M. Color Filter Frame Holder: Attached to front of fixture.
- N. Fixture Yoke: Rigid metal arranged for vertical aiming of unit and equipped with T-bolt or hand screw to lock alignment.

## 2.3 FIXTURES

- A. General: Listed under UL 1573.
- B. Standard Features: Equip each fixture with pigtail, yoke with pipe clamp, and safety cable for batten mounting, and filter holder.
- C. Color mixing Ellipsoidal fixture
  - 1. General
    - a. The fixture shall be a color-mixing high-intensity LED illuminator with DMX control of intensity and color. The fixture shall be a Source Four LED Series 2 as manufactured by Electronic Theatre Controls, Inc. or approved equal.
    - b. The fixture shall be UL 1573 listed for stage and studio use.
    - c. The fixture shall comply with the USITT DMX-512A standard.
  - 2. Physical
    - a. The unit shall be constructed of rugged, die cast aluminum, free of burrs and pits, finished in black.
    - b. The following shall be provided:
      - 1) Lens secured with silicone shock mounts.
      - 2) Shutter assembly shall allow for +/-25° rotation.
      - 3) 20 gauge stainless steel shutters.
      - 4) Interchangeable lens tubes for different field angles with Teflon guides for smooth tube movement.
      - 5) Sturdy integral die cast gel frame holders with two accessory slots, and a top-mounted, quick release gel frame retainer.
      - 6) Rugged steel yoke with two mounting positions allowing 300°+ rotation of the fixture within the yoke.
      - 7) Positive locking, hand operated yoke clutch.
      - 8) Slot with sliding cover for motorized pattern devices or optional iris.
    - c. Power supply, cooling and electronics shall be integral to each unit.
    - d. The unit shall ship with:
      - 1) Theatrical-style hanging yoke as standard.
      - 2) 5' Neutrik PowerCon™ to Edison power cable as standard.
      - 3) Gate diffuser.
      - 4) A-size pattern holder.
  - 3. Optical
    - a. The light beam should have a 2-to-1 center-to-edge drop-off ratio
    - b. The unit shall provide, but not be limited to:
      - 1) 5, 10, 14, 19, 26, 36, 50, 70 and 90 degree field angles.
      - 2) High-quality pattern imaging.
      - 3) Sharp shutter cuts without halation.
      - 4) Shutter warping and burnout in normal use shall be unacceptable.
      - 5) Adjustable hard and soft beam edges.

THEATRICAL LIGHTING AND CONTROL SYSTEM

- c. 19, 26, 36, and 50 degree units shall have optional lens tubes available for precision, high-contrast imaging.
- 4. Thermal
  - a. Fixture shall be equipped with a cooling fan.
    - 1) Fan speed control via a DMX channel shall be possible.
    - 2) Fan speed software shall permit the fixture to override DMX fan speed setting to prevent heat damage to the fixture.
  - b. The fixture shall utilize advanced thermal management systems to maintain LED life to an average of 70% intensity after 54,000 hours of use (Lustr).
- 5. Electrical
  - a. The fixture shall be equipped with a 100V to 240V 50/60Hz internal power supply.
  - b. The fixture shall support power in and thru operation.
  - c. Power supply shall have power factor correction.
- 6. LED Emitters
  - a. The fixture shall contain a minimum of four different LED colors to provide color characteristics as described in the Color Section below.
  - b. All LEDs used in the fixture shall be high brightness and proven quality from established and reputable LED manufacturers.
  - c. Manufacturer of LED emitters shall utilize an advanced production LED binning process to maintain color consistency.
  - d. Fixtures shall have adjustable PWM frequency up to 25,000hz to avoid flicker on camera.
- 7. Calibration
  - a. Fixture shall be calibrated at factory for achieve consistent color and intensity output between fixtures built at different times and/or from different LED lots or bins.
    - 1) Calibration data shall be stored on the LED array as a permanent part of on-board operating system.
    - 2) All arrays, including replacement arrays shall be calibrated to the same standard to insure consistency.
    - 3) Fixtures not offering LED calibration shall not be acceptable.
- 8. Color
  - a. The fixture shall utilize a minimum of 60 LED emitters
  - b. The fixture shall be available in specialized LED arrays as outlined below:
    - 1) Red, Amber, Green, Cyan, Blue, Indigo and Lime LEDs in an array designed for broad spectrum color, light tints, and variable whites. This array shall be the Lustr array as manufactured by Electronic Theatre Controls, or approved equal.
      - a) Measured brightness of the Lustr array shall be greater than 6,500 field lumens.

9. Control and User interface

- a. The fixture shall be USITT DMX 512A-compatible via In and Thru 5-pin XLR connectors.
- b. The fixture shall be equipped with multi-line LCD display for easy-to-read status reports and configuration changes.

10. The fixture shall be capable of copying all performance settings to other fixtures of the same type via a 5 pin XLR DMX cable.

11. **Finish: White**

12. Fixtures shall be provided as follows:

- a. Front of House Beams: 2 – 19 deg., 4 – 26 deg., 2 – 36 deg.

D. Color mixing PAR fixture

1. General

- a. The fixture shall be a color-mixing high-intensity LED illuminator with DMX control of intensity and color. The fixture shall be a ColorSource PAR as manufactured by Electronic Theatre Controls, Inc. or approved equal.
- b. The fixture shall be UL 1573 listed for stage and studio use.
- c. The fixture shall comply with the USITT DMX512-A standard.
- d. The fixture shall be provided with the minimum warranty of 5 years full fixture coverage and 10 years LED array coverage.
- e. The fixture shall have a LM-84 report with a L70 rating of no less than 55,000 hours.

2. Physical

- a. The fixture shall be contained in a rugged all-metal die-cast housing, free of burrs and pits, finished in black.
- b. Power supply, cooling and electronics shall be integral to each unit.
- c. Fixture housing shall provide two easy-access slots for secondary lenses and other accessories.
  - 1) Slots shall be equipped with locking retaining clip.
- d. The unit shall ship with:
  - 1) Theatrical-style hanging yoke as standard.
  - 2) 5' power lead with Edison connector as standard.
- e. Light output shall be via a round aperture.
  - 1) Aperture and accessory slots shall accommodate standard 7.5" accessories such as used in other similar-sized fixtures.

3. Thermal

- a. The fixture shall be cooled with a variable speed fan.
- b. The fixture shall utilize advanced thermal management systems to maintain LED life to an average of 70% intensity after 20,000 hours of use for color mixing versions.
- c. The fixture shall operate in an ambient temperature range of 0°C (32°F) minimum, to 40° C (104°F) maximum ambient temperature.

THEATRICAL LIGHTING AND CONTROL SYSTEM

4. Electrical

- a. The fixture shall be equipped with 100V to 240V 50/60 Hz internal power supply.
- b. The fixture shall support power in and thru operation.
- c. Power supply shall have power factor correction.

5. LED Emitters

- a. The fixture shall contain 4 different LED colors to provide color characteristics, as described in Section H below.
- b. All LEDs used in the fixture shall be high brightness and proven quality from established and reputable LED manufacturers.
- c. Manufacturer of LED emitters shall utilize an advanced production LED binning process to maintain color consistency.

6. Calibration

- a. Fixture shall be calibrated at factory for achieve consistent color between fixtures built at different times and/or from different LED lots or bins.
  - 1) Calibration data shall be stored in the fixture as a permanent part of on-board operating system.
  - 2) All arrays, including replacement arrays shall be calibrated to the same standard to insure consistency.
  - 3) Fixtures not offering LED calibration shall not be acceptable.

7. Color

- a. The fixture shall utilize a minimum of 40 LED emitters.
  - 1) These emitters shall be made up of Red, Green, Blue and Lime for ColorSource.

8. Control And User Interface

- a. The fixture shall be USITT DMX512-A compatible via In and Thru 5-pin XLR connectors.
- b. The fixture shall be equipped with a display for easy-to-read status and control.

9. Fixtures shall be provided as follows:

- a. Stage Electrics (typ. Of 2): 4.

E. Color Mixing Cyclorama Fixture

1. General

- a. The fixture shall be a color-mixing high-intensity LED illuminator with DMX control of intensity and color. The fixture shall be a ColorSource® CYC as manufactured by Electronic Theatre Controls, Inc. or approved equal.
- b. The fixture shall be UL 1573 listed for stage and studio use
- c. The fixture shall comply with the USITT DMX512-A standard

2. Physical

- a. The fixture shall be contained in a rugged all-metal die-cast housing, free of burrs and pits, finished in black.

THEATRICAL LIGHTING AND CONTROL SYSTEM

- b. Power supply and electronics shall be integral to each unit.
  - c. Fixture housing shall provide built in spill control
  - d. Fixture shall operate directly on the ground or by hanging via yoke.
  - e. The unit shall ship with:
    - 1) Theatrical-style hanging yoke as standard.
    - 2) 5' power lead with Neutrik® PowerCON™ to Edison connector as standard.
  - f. Light output shall produce an asymmetrical beam
    - 1) Lensing shall be designed to provide smooth coverage both horizontally and vertically for seamless blending from fixture to fixture.
    - 2) With a minimum setback from the cyclorama of 2', the fixtures shall be able to achieve a 2-to-1 spacing ration and maintain smooth coverage.
- 3. Thermal
  - a. The fixture shall be natural convection cooled and shall not use a fan.
  - b. The fixture shall utilize advanced thermal management systems to maintain LED life to an average of 70% intensity after 50,000 hours of use.
- 4. Electrical
  - a. The fixture shall be equipped with 100V to 240V 50/60 Hz internal power supply
  - b. The fixture shall support power in and thru operation.
  - c. Power supply shall have power factor correction.
- 5. LED Emitters
  - a. The fixture shall contain 5 different LED colors to provide color characteristics as described below.
  - b. All LEDs used in the fixture shall be high brightness and proven quality from established and reputable LED manufacturers.
  - c. Manufacturer of LED emitters shall utilize an advanced production LED binning process to maintain color consistency.
  - d. Fixtures shall have a flicker free mode that will set the LED refresh rate to 25,000 Hz for flicker free operation on camera.
- 6. Calibration
  - a. Fixture shall be calibrated at factory for achieve consistent color between fixtures built at different times and/or from different LED lots or bins.
    - 1) Calibration data shall be stored in the fixture as a permanent part of on-board operating system.
    - 2) All arrays, including replacement arrays shall be calibrated to the same standard to ensure consistency.
    - 3) Fixtures not offering LED calibration shall not be acceptable.
  - b. Fixture shall have droop compensation to overcome thermal droop in the LEDs to maintain output levels and color point.

THEATRICAL LIGHTING AND CONTROL SYSTEM

7. Color
    - a. The fixture shall utilize a minimum of 42 LED emitters
      - 1) These emitters shall be made up of Red, Green, Blue, Indigo and Lime.
  8. Control and User Interface
    - a. The fixture shall be USITT DMX512-A compatible via In and Thru 5-pin XLR connectors or RJ45 connectors.
    - b. The fixture shall be equipped with a display for easy-to-read status and control.
  9. Fixtures shall be provided as follows:
    - a. Stage Electric #2: 4.
- F. LED RGBA Borderlights: Provide c-clamps, Edison style parallel plug, and safety cable as described above.
1. General
    - a. The fixture shall be a colour-mixing high-intensity LED illuminator with DMX control of intensity and colour. The fixture shall be a ColorSource Linear (ColorSource Linear Deep Blue or ColorSource Linear Pearl) 1, 2 or 4 as manufactured by Electronic Theatre Controls, Inc. or approved equal.
    - b. The fixture shall be UL 1573 listed for stage and studio use.
    - c. The fixture shall comply with the USITT DMX512-A standard.
  2. Physical
    - a. The fixture shall be contained in a rugged all-metal die-cast and/or sheet metal housing, free of burrs and pits.
    - b. The housing shall have a rugged black powder-coat finish
    - c. Power supply, cooling and electronics shall be integral to each unit.
    - d. Fixture housing shall provide two easy-access slots for secondary lenses and other accessories
      - 1) Slots shall be equipped with locking cover on both ends of the fixture
    - e. Each LED optic shall be spaced for optimal photometric performance
      - 1) The units shall allow for being placed end to end while maintaining optical spacing to prevent scalloping between fixtures
    - f. Accessories available as options shall include but not be limited to:
      - 1) Hanging yoke for the Linear 1
      - 2) Double hanging yoke for the Linear 1
      - 3) PowerCON to PowerCON cables for fixture power linking
      - 4) Multiple secondary lens options to include multiple angles
      - 5) Barn doors
      - 6) Egg crate louvers
  3. The fixture shall be CE compliant and UL and cUL LISTED, and shall be so labelled when delivered to the job site.



THEATRICAL LIGHTING AND CONTROL SYSTEM

4. Thermal

- a. The fixture shall be cooled with a quiet, variable speed fan.
- b. The fixture shall utilise advanced thermal management systems to maintain LED life to an average of 70% intensity after 20,000 hours of use for colour mixing versions and 36,000 hours of use for Pearl variety

5. Electrical

- a. The fixture shall be equipped with 100V to 240V 50/60 Hz internal power supply
- b. The fixture shall support power in and thru operation
- c. Power supply outputs shall have self-resetting current limiting protection
- d. Power supply shall have power factor correction

6. LED Emitters

- a. The fixture shall contain 4 different LED colours to provide colour characteristics or two colour temperature white LEDs for the Pearl products, as described in Section H below.
- b. All LEDs used in the fixture shall be high brightness and proven quality from established and reputable LED manufacturers.
- c. Manufacturer of LED emitters shall utilize an advanced production LED binning process to maintain colour consistency.
- d. LED emitters should be rated for nominal 20,000-hour L70 rating for colour mixing versions and 36,000-hour L70 rating for Pearl variant
- e. Fixture shall be calibrated at factory for achieve consistent colour between fixtures built at different times and/or from different LED lots or bins
  - 1) Calibration data shall be stored in the fixture as a permanent part of on-board operating system
  - 2) All arrays, including replacement arrays shall be calibrated to the same standard to insure consistency
  - 3) Fixtures not offering LED calibration shall not be acceptable

7. Colour

- a. The fixture shall utilize a minimum of 40 LED emitters
  - 1) These emitters shall be made up of Red, Green, Blue and Lime for ColorSource

8. Dimming

- a. The LED system shall use 15-bit nonlinear scaling techniques for high-resolution dimming.
- b. The dimming curve shall be optimised for smooth dimming over longer timed fades while responding quickly to bumps.
- c. The LED system shall be digitally driven using high-speed pulse width modulation (PWM)
- d. LED control shall be compatible with broadcast equipment in the following ways:
  - 1) PWM control of LED levels shall be imperceptible to video cameras and related equipment
  - 2) PWM rates shall be adjustable by the user via RDM to avoid any visible interference to video cameras and related equipment

9. Control And User Interface

- a. The fixture shall be USITT DMX 512A-compatible via In and Thru 5-pin XLR connectors

THEATRICAL LIGHTING AND CONTROL SYSTEM

- b. Each half meter of length shall be individually addressable and controllable
    - 1) All fixture functions shall accessible via RDM protocol for modification from suitably equipped control console
  - c. The fixture shall be equipped with a 7-segment display for easy-to-read status and control
10. Stage Electrics (typ. of 2): 3 – 1 meter, 3 – 2 meters
- G. Power-Con Connectors: Provide power-con connections as required to connect all light fixtures.

2.4 LAMPS

- A. Anywhere LED fixtures are specified, provide with LED array as specified and DMX communications. Provide with wattage and light output as per basis of design fixture.
- B. Where non-LED fixtures are specified: Comply with the standard of the ANSI C78 series that is applicable to each type of lamp. Where lamps of designated type, characteristics, and wattage are not indicated, provide lamps recommended by manufacturer of fixture in the highest wattage for which fixture is listed.

2.5 DISTRIBUTION COMPONENTS

- A. Connector Strips: Factory-wired wire ways and receptacle assembly.
  - 1. Wireway: 16 Ga. steel construction with screw covers with a 4.25" X 2.5" cross section. Length as required in 5' increments.
  - 2. Receptacles as scheduled:
    - a. Stage: Grounded parallel blade with flush or 18" pigtail and strain relief on non-dim relays at wireway wall penetration mounting as scheduled below.
    - b. Grounded flush parallel blade constant output receptacles to provide power for future wireless DMX modules.
  - 3. Receptacles Wiring: Connect to terminal blocks with 125-deg C, cross-linked, polyethylene insulated wire.
  - 4. Ground lug.
  - 5. Mounting: Steel mounting straps to wrap around the wireway and located at 5' intervals. Mounting straps to include a formed section to attach to 1-1/2" (2" OD max.) schedule 40 pipe.
    - a. **The use of chain to mount connector strips or pipes shall not be acceptable.**
  - 6. Electrical contractor to provide 1-1/2" schedule 40 black iron pipe with all joints made with bolted thru couplings as required for stage connector strips. Pipe shall extend a minimum of 2 feet beyond each end of the wire way. Provide steel mounting straps and wire as required for installation. Ensure industry standard safety factors are utilized for all weight calculations.
  - 7. Provide:
    - a. Stage Electrics (typ. Of 2): 99+30'-(3AO/1ND)-(10AP/1ND)(1AO/1C(in center))(1DMX PassThruPanel(in center))-22.
      - 1) Both pipes shall be by the Division 26 Contractor.
      - 2) Evenly distribute the (3) 'AO' receptacles along connector strip.

B. Receptacle Plug-in Boxes:

1. Box: Welded steel, minimum of 16 gauge, with removable cover.
2. **Finish: White**
3. Receptacles: Flush mounted, grounded parallel blade receptacles.
4. Receptacles Rating: Grounded 20A parallel blade.
5. Ground lug.
6. Mounting: Surface at the lighting cage.
7. Mounting: Provide mounting accessories as required to install at cage.
8. Provide: 2 – 9104A (4 Edison outlets). Locate one at each cage.
9. Provide additional DMX jack at each location for fixture control.
10. Locate plug-in boxes on stage walls to provide best use, and meet all ADA requirements.

C. Spotlight Cages

1. Welded steel frame with a wire mesh grid on the four side and bottom panels.
2. Hinged bottom panel with latches and secure the panel when closed.
3. Cage to hold four (4) spotlights.
4. Mounted to building joists as required. Provide 1-1/2" schedule 40 pipe for mounting spotlights with finish matching cage.
5. Provide sufficient strength steel and mesh to protect lights from balls and other flying objects in a gymnasium environment.
6. **Finish: White enamel paint.**
7. Provide:
  - a. Front of house beams: 2 cages capable of holding spotlights listed above.

D. Gridiron Junction Boxes: Grid mounted box with terminals for contractor termination of load circuits.

1. Box: Welded steel, minimum of 16 gauge, with removable cover.
2. Terminal Blocks: Molded barrier type with screw lugs to suit supply conductors.
3. Ground lug.
4. Mounting: Surface.
5. Provide: One (1) box per stage electric and front of house bar, sized to handle circuits.

E. Multi-conductor Cable: Flexible, multiple conductor cable with a SO jacket.

1. Length as required to interconnect the border lights to the grid junction box.
2. Minimum 12-gauge, stranded wire with color-coded insulation.
3. Two wires per circuit plus ground and 10% spares.
4. Strain relief grips installed at each end of cable.
5. Provide cradle as required to support cable.

F. Cable Management:

1. Provide spring wheels, sized to handle the power cable, for each stage electric and front of house bar(s) that is designed to be lowered.
2. Provide spring wheels, sized to handle the DMX and other control cable, for each stage electric and front of house bar(s) that is designed to be lowered.
3. Refer to architectural drawings and rigging specifications to determine which bars are designed to be lowered, and will subsequently require cable management.
4. Install cable management where required for full functionality. Coordinate exact location with the rigging installer.

THEATRICAL LIGHTING AND CONTROL SYSTEM

2.6 LIGHTING CONTROL SYSTEM

- A. Description: Microprocessor-based, modular system consisting of dimmer and control modules operated from remote-control stations and a control console.
1. Comply with UL891.
  2. Comply with USITT DMX 512-A for data transmission.
- B. STAGE DIMMER RACK: wall-mounted panel with a welded steel frame and locking door over the dimmers. Main and neutral lugs: Rated to 100 amps per phase for 120/208V, 60Hz, 3 phase, 4 wire operation. Visible indicator lights for each phase. Provide the Unison Echo series by ETC.
1. General
    - a. The wall mount relay panel shall be the Echo Relay Panel as manufactured by ETC, Inc., or equal
    - b. Relay Panels shall be UL508, UL67, and UL924 Listed, and shall be so labeled when delivered
    - c. Relay Panels shall consist of a main enclosure with 30 pole breaker subpanel, relay/dimmer sub panel, integral control electronics, and a low voltage subpanel for data terminations and provision for accessory cards
      - 1) Up to two accessory cards shall be supported per relay panel
  2. Mechanical
    - a. The panel shall be constructed of 16-gauge steel. All panel components shall be properly treated and finished in fine-textured, scratch resistant paint
    - b. Relay panels shall be available in 120 and 277 Volt AC configurations
      - 1) 120V enclosures shall be 67.5" high by 14.36" wide and 4" deep with a weight not more than 80 pounds
      - 2) 277V enclosures shall be 67.5" high by 20" wide and 6" deep with a weight not more than 130 pounds
    - c. The panel shall be capable of being mounted on the surface of a wall or recessed mounted
      - 1) 120VAC panels shall support mounting between standard wall stud framing (16-inch on center spacing)
    - d. Choice of panel covers shall be available for surface or recess mount applications. This outer panel shall ship complete with a locking door to limit access to electronics and breakers, breakers
      - 1) Optional center-pin reject security screws shall be available for all accessible screws
      - 2) Recess mount doors shall extend 1" beyond all panel edges to hide wall cut-out
    - e. The unit shall provide interior cover over breaker panel to allow access only to class 2 wiring and prevent direct access to class 1 line voltage components
    - f. The Relay panel shall support up to twenty-four 20-amp single pole circuits made up of relays (120V and 277V enclosures) or 300W dimmers (120V enclosures only)
      - 1) Two and three-pole relay circuits shall be supported at decreased density where each pole constitutes one of the available single-pole circuits. Mixing of circuits in any combination shall be supported

THEATRICAL LIGHTING AND CONTROL SYSTEM

- 2) Panels that do not support an integral dimmer module shall not be acceptable
  - g. Relays shall include integral switches for manual control while power is unavailable to the panel such that critical lighting can be set to an on state, without the need for power to the panel
  - h. Relay output lugs shall accept 6-14AWG copper wire
  - i. Breaker subpanel may include up to twenty-nine 20-amp single pole, up to fourteen 20 amp double pole, or nine three pole breakers as required in any combination up to capacity
  - j. Control wiring for DMX, station bus, and Emergency input terminations shall land on removable headers for contractor installation.
3. User Interface
- a. The user interface shall contain a graphical display with button pad to include 0-9 number entry, up, down back arrow navigation and enter
  - b. Test shortcut button shall be available for local activation of preset, sequence and set level overrides
  - c. The user interface shall have a power status LED indicator (Blue), a DMX status LED indicator (Green), a network status LED indicator (Green) and an LED indicator (red) for errors
  - d. Interface shall allow the backlight to timeout and shall provide user editable options to shut off backlight completely as well as adjust screen contrast
  - e. Ethernet interface shall default to automatic IP through link local and DHCP. Upon receiving IP address, the address of the Network Interface Card (NIC) shall display in the about menu. Static address and settings shall also be possible
  - f. The control interface shall support a USB memory stick interface for uploads of configurations and software updates
4. Functional
- a. Panel setup shall be user programmable. The control interface shall provide the following relay setup features (per circuit):
    - 1) Type (1 pole, 2 pole, or 3 pole)
    - 2) Name
    - 3) Circuit Number
    - 4) DMX address
    - 5) sACN address
    - 6) Space Number
    - 7) Circuit Modes
      - a) Normal (priority and HTP based activation and dimming)
      - b) Latch-lock
      - c) Fluorescent
      - d) DALI
    - 8) On threshold level
    - 9) Off threshold level
    - 10) Include in UL924 emergency activation
    - 11) Allow Manual
  - b. Relay panels shall support discrete addressing of each relay. Panels that are restricted to use of start address with sequential addressing and cannot assign each 0-10V output control to any internal relay shall not be acceptable

THEATRICAL LIGHTING AND CONTROL SYSTEM

- c. The panel shall be capable of switching all relays on or off at once, or in a user-selectable delay per relay using a period of 0.1 to 60 seconds, in 0.1 second increments
- d. An Ethernet connection shall provide advanced control of relays over streaming ACN (sACN) and transmit status, control override, and measured energy usage per branch circuit via an internal Web UI or central monitoring interface
  - 1) Control electronics shall report the following information per branch circuit
    - a) Breaker state (On/Off)
    - b) Breaker state (Open/Closed)
    - c) Current draw (In Amps)
    - d) Voltage
    - e) Energy usage
  - 2) Panels that do not report this information shall not be acceptable
- e. Built-in Control shall include:
  - 1) Ability to record up to 16 presets in each space from the control panel, connected control stations, or timed events
  - 2) Presets shall be programmable by recording current levels (as set by DMX or connected control stations), by entering levels on the control panel directly, manually selecting relay state on each relay or a combination of these methods. From the control panel, stations, or timed events it shall be possible to record values for up to 16 zones per space
  - 3) Up to 8 spaces in a single rack for total of up to 16 spaces shall be supported per system or system subnet
  - 4) Indication of an active preset shall be visible on the control panel display
  - 5) One 16-step sequence per space for power up and power down routines
  - 6) The panel shall have a UL924-listed contact input for use in Emergency Lighting systems. The panel shall respond to the contact input by setting included relays to "on", while setting non-emergency relays "off". Each relay can be selected for activation upon contact input
  - 7) Upon Data loss the system shall provide options to hold last look infinitely or hold for a configured time period set by the installing technician then fade/switch to the input of the next available priority
  - 8) Control electronics shall respond directly to control stations for zone, preset, and sequence control. Systems that require secondary control systems for this functionality are not acceptable
  - 9) After power loss, electronics shall be capable of holding the system in its previous state until new level data (DMX, architectural presets, sequences and zones, or local overrides) is received to make each relay change state
- f. The control of lighting and associated systems via real time and Astronomical clock controls
  - 1) The relay panel shall allow the activation of presets, sequence, and zone programming of up to 50 time clock events via a built in real and astronomical timeclock
  - 2) System time events shall be programmable via the control panel.
    - a) Time clock events shall be assigned to system day types. Standard day types include: everyday, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday
    - b) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event

THEATRICAL LIGHTING AND CONTROL SYSTEM

- c) System shall automatically compensate for regions using a fully configurable daylight saving time
  - d) Presets shall be assigned to events at the time clock
- 3) The time clock shall support event override
  - a) It shall be possible to override the timed event schedule from the face panel of the time clock
- 4) The time clock shall support timed event hold
  - a) It shall be possible to hold a timed event from the face panel of the processor
  - b) Timed event hold shall meet California Title 24 requirements
- g. The panel shall receive ESTA DMX512-A control protocol. Addressing shall be set via the user interface button keypad with any relay being patched to any DMX control address
  - 1) 2,500V of optical isolation shall be provided between the DMX512 inputs and the control electronics as well as between control and power components
  - 2) The relays shall respond to control changes (DMX or Stations) in less than 25 milliseconds. DMX512 update speed shall be 40Hz
  - 3) Setting changes shall be able to be made across all, some, or just one selected relay in a single action from the face panel
  - 4) DMX data loss shall allow for levels/relays to be held for ever or for a specified time before switching to a lower priority source
  - 5) Initial Panel setup
    - a) The relay panel shall automatically detect the type of relay or dimmer installed in each location without need for manual configuration of the physical arrangement.
    - b) Quick rack setup shall be available to apply address settings across all circuits for rack number, DMX Start Address, sACN universe, and sACN start address.
    - c) Emergency Setup Menu shall provide optional delays when emergency is activated or deactivated, and option to turn off non-emergency circuits shall be available. Record function shall allow circuits that are turned on to be added to the emergency setting

5. Electrical

- a. Relay Panels shall be available to support power input from:
  - 1) 120/208V three phase 4-wire plus ground
  - 2) 120/240V single phase 3-wire plus ground
  - 3) 277/480V, 230/400V and 240/415V three phase. 4-wire plus ground
- b. Conduit Entry:
  - 1) Feeders:
    - a) Top or top-side (upper 6" of either side)
    - b) Bottom or bottom-side 6" of either side
    - c) Feeders shall enter through the top or bottom according to the orientation of the enclosure
    - d) Feeder entry shall be nearest to the location of the feeder lugs or main breaker

THEATRICAL LIGHTING AND CONTROL SYSTEM

- 2) Load:
  - a) Load wiring shall enter through the top or bottom of the enclosure
  - b) Load wiring shall enter through the top/bottom surface nearest to the breaker sub panel
  - c) Load wiring may also enter through left and/or right side provided a low voltage chase is not required through the same area. If class 2 chase is required, a field installable barrier panel shall be provided upon request. When installed, the left or right side of the panel, where the barrier has been installed, shall not permit load wiring

- 3) Low Voltage:
  - a) Top or top-side (upper 6" of either side)
  - b) Bottom or bottom-side (bottom 6" of either side)
  - c) For low voltage conduit entry at the relay end of the cabinet, conduits shall be located at the outer 3" of the top/bottom panel
  - d) Field installed low voltage channel shall be provided separately for installation on the left or right side of the panel to allow class 2 wiring to traverse the panel from top to bottom or bottom to top

- c. All relays shall be mechanically latching
- d. The relay shall be capable of switching 20A at up to 300V
- e. The relay panel shall support a maximum feed size of 200 Amps
- f. Relay panels shall support main circuit breaker options:
  - 1) Main breaker options shall be optional and available for purchase upon request
  - 2) Main breakers shall be field installable
  - 3) Main breakers shall be available in 100 and 200 Amps for 120V systems and 150 Amps for 277V systems
  - 4) Series rated SCCR ratings apply as follows with appropriate main breaker:
    - a) 22,000A at 120/240V
    - b) 10,000A at 100A; 120/208V
    - c) 10,000A, 22,000 or 42,000 at 200A; 120/208V
    - d) 14,000A at 150A and 200A; 277V/480V
    - e) 65,000A at 200A; 277V/480V
  - 5) Main breakers shall allow the following range of wire sizes:
    - a) 1AWG-300kcmil at 120/240V
    - b) 3/0 to 300kcmil at 120/208V
    - c) 6AWG-300kcmil at 277V/480V

6. Relay

- a. Each relay shall have a manual override switch with on/off status indication
- b. Relays shall be rated for use with:
  - 1) 16A Electronic Ballast loads @ 120, 240 and 277V
  - 2) 20A Tungsten loads at 120, 240, and 277V
  - 3) 20A 277V Ballast (HID)
  - 4) Motor loads with ratings of 20 FLA @ 120V, 17 FLA @ 240V, and 14 FLA @ 277V



THEATRICAL LIGHTING AND CONTROL SYSTEM

- c. Isolation shall be 4000V RMS
  - d. Relays shall be latching state
  - e. Rated Life:
    - 1) 1,000,000 mechanical activations
    - 2) 100,000 cycles at full resistive load
    - 3) 30,000 cycles full motor, inductive, tungsten, and electronic (LED)
    - 4) Decreasing loading shall increase the rated life of the relay inversely proportional the square of the load
  - f. Relays shall support reporting of current usage with an accuracy of five percent of the connected load
7. Dimmer Modules (120V enclosures only)
- a. Dimmer modules shall be available as either forward-phase or phase-adaptive
  - b. Dimmer modules shall be fully rated for loads up to 300W
  - c. By default, phase-adaptive dimmers shall automatically detect the required dimming mode based on connected loads and lock the mode in at power-up
  - d. The forward-phase dimmer shall support tungsten/incandescent, 2-wire fluorescent, and magnetic transformer loads
  - e. The phase-adaptive dimmer shall support tungsten/incandescent, line-drive LED, and electronic transformer loads
  - f. Panels without available dimmers that support magnetic loads shall not be acceptable
  - g. The panel shall support a maximum phase dimming load of 7,200W if populated fully with (24) 300W dimmer modules. Panels that do not support phase dimmers and relays combined in a single panel shall not be acceptable
8. Relay Panel Accessories
- a. A low voltage 0-10V dimming option shall provide up to 24 0-10v control outputs that are linked to relay circuits within the panel. Each output shall support up to 400mA of current sink per output
  - b. A contact input option shall provide 24 dry contact inputs to be linked for direct or group relay control, to activate a preset, or to activate a sequence. Controller software shall allow for normally open maintained, normally closed maintained, or momentary toggle
  - c. A DALI control option shall provide 24 control loops of broadcast DALI control, with each loop controlling up to 64 DALI devices
  - d. A RideThru option shall provide short-term power backup of control electronics by automatically engaging when power is lost, and recharging when normal power is present
  - e. A tamperproof hardware kit shall be available that provides center reject Torx head screws to prevent access to panel interior by unqualified individuals
9. Main Breaker options shall be available as specified in Section E.6 Thermal
- a. The panel shall be convection cooled. Panels that require the use of cooling fans shall not be acceptable
  - b. The panel shall operate safely in an environment having an ambient temperature between 32°F (0°C) and 104°F (40 C), and humidity between 5-95% non-condensing

THEATRICAL LIGHTING AND CONTROL SYSTEM

10. Provide: Dimmer panel with:
  - a. Stage Lighting:
    - 1) 10 - 20A non-dim relays.
      - a) 4 of the non-dim relays shall be spare.
    - 2) 2 - 20A constant breakers.
- C. Control Console: Control console to meet or exceed the ETC ColorSource 40 Console (CS40) as specified below:
  1. General
    - a. 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 ColorSource 20 or ColorSource 40 as manufactured by Electronic Theatre Controls, Inc., or equal.
    - b. The system shall provide control of 512 DMX512A addresses on a maximum of eighty (80) control channels. Any or all of the DMX512A outputs may be controlled by a channel.
    - c. A maximum of 999 cues may be contained in non-volatile electronic memory.
    - d. Twenty (20) or forty (40) faders shall provide access to individual intensity channels, intensity for devices as well as playbacks.
    - e. Four (4) configurable faders shall provide functionality for output of bump buttons, cue list control or crossfade control.
    - f. The console shall have one (1) built-in 7" color multi-touch touchscreen. The touchscreen shall provide the primary interface for system configuration, programming show data and multi-parameter control.
    - g. Six (6) softkey buttons shall be provided, five of which may be configured by the user.
    - h. Console shall be equipped with an on-board help system.
    - i. Console shall not require the use of an external monitor for normal use.
    - j. Console software upgrades shall be made by the user via USB drive. Changing internal components shall not be required.
    - k. The console shall provide a USB port allowing show data to be saved for archival or transfer to other consoles or a personal computer.
    - l. Systems that do not provide the above capabilities shall not be acceptable.
  2. Controls and Playback
    - a. Patching
      - 1) The console shall provide patching facilities for dimmers and multi-parameter devices via a built in library of fixture definitions. The fixture library shall be updated via software based updates. It shall be possible to create custom fixture definitions using an offline application.
      - 2) The console shall support patching, address setting, and mode changes using Remote Device Management (RDM) on the local DMX/RDM port.
    - b. Channel or Playback Faders
      - 1) Twenty (20) or forty (40) proportional, fully overlapping faders shall be provided with 45mm potentiometers and bump buttons.

THEATRICAL LIGHTING AND CONTROL SYSTEM

- 2) The faders shall provide direct manual control of intensity for all channels. Channel levels can be changed at any time by using the individual channel faders or through the use of the touch screen interface.
  - a) Faders shall also control up to ten (10) pages of twenty (20) (or forty (40)) recordable memories or sequences. Memories shall record user-selected channel levels. Sequences shall record user-selected memories or channel levels.
    - i) With color mixing systems, output of color from fixtures shall appear to be a combination of the active memories in a color space.
- c. Programming Tools
  - 1) The console shall provide a 7" color multi-touch touchscreen with six (6) softkeys, as well as touch-based controls. The LCD shall provide system configuration, programming show data and multi-parameter control.
  - 2) Touch-based tools shall include:
    - a) White and color pickers.
    - b) Touch-based parameter controls with reference-based palettes.
    - c) Virtual Level/Rate wheel.
    - d) Virtual keypad for level entry.
    - e) Customizable channel display using Stage Map. It shall be possible to rearrange the graphical representations for control channels to closely mimic the positions of fixtures in the venue.
    - f) Effects (intensity, color, shape, and parameter)
      - i) It shall be possible to assign multiple effects to the same channel and parameters. The playback of those effects shall play levels back relative to the combination of the two effects.
  - 3) Fixture selection shall be made via:
    - a) Auto fixture selection on fader moves.
    - b) Pressing the selection button under channel faders.
    - c) Touching the channel icon in the stage map display on the touch screen.
    - d) Fixture Tags for Quick Selects
      - i) Selection of multiple fixture shall be possible through a special controls dock that groups channels together based on the channel tile positions within a pre-defined area in the topographical view for channels.
      - ii) Selection shall be possible through the use of informational tags. Selecting a predefined tag selects all fixtures sharing that same tag. At least two tags may be assigned to any one channel.
      - iii) There shall be at least 27 Quick Select groupings.
  - 4) Two independent channels shall be provided with on/off functionality. Independents shall be patched in a location separate from patch.
- d. Playback Controls
  - 1) A cue list of up to 999 cues shall be provided. Cues may be made up of channel levels and parameter settings or contain a reference to a recorded memory. Cues shall be editable and shall be able to be individually deleted and inserted.

THEATRICAL LIGHTING AND CONTROL SYSTEM

- 2) Playback Toy for filtered and timed execution of playbacks.
    - 3) Multiple bump modes (Flash, Solo, SoloChange, Move/GO).
    - 4) Full history rubberbanding for playbacks.
  3. Interface Options
    - a. The console shall provide connectors for the following:
      - 1) 12V AC or DC input for external power supply
      - 2) DMX512-A/RDM output (one (1) 5-pin XLR connector)
      - 3) USB connection (one (1) type A connector)
  4. Physical
    - a. All operator controls and console electronics shall be housed in a single desktop console.
    - b. Size and weight:
      - 1) Twenty (20) fader console shall be equal to or less than 18.31" (465mm) wide 11" (279mm) deep 2.36" (60mm) high (including controls), and 6.9 lbs. (3.13 kg.)
      - 2) Forty (40) fader console shall be equal to or less than 26.31" (668mm) wide 11" (279mm) deep 2.36" (60mm) high (including controls) and 9.55 lbs. (4.33kg).
    - c. Twenty (20) fader console shall be able to be mounted into a 19" equipment rack with the use of additional mounting hardware.
    - d. Console power shall be 12V AC or DC via an external power unit. The power unit shall operate with 90-265VAC line voltage, 50 or 60Hz. Console is provided with a universal power supply.
  5. Console receptacle stations for remote console operation. Provide on the stage and at the control locations indicated. Receptacle stations shall be a single-gang faceplate.

D. Wall Controls

  1. Stage Manager's Panel: Surface mounted steel cabinet with a hinged locking cover and a painted finish. Mount on the stage area as shown on the drawings.
  2. Functional
    - a. Supports 80 control channels
    - b. One universe of output and control of devices in all 16 Echo spaces
    - c. Supports playback of 64 Presets and 4 internal Sequences with one active at any time
    - d. User customized touchscreen interface with support for layout and naming of:
      - 1) Seven User pages
      - 2) Zone faders (up to 11 per page)
      - 3) Preset, Sequence and Off buttons (up to 30 per page)
      - 4) Channel and Space Modification buttons
      - 5) Space Combine buttons
      - 6) Six user definable utility buttons
    - e. Color and White Pickers
    - f. Innovative touch-based parameter controls with Reference based Position, Color and Beam palettes
    - g. On-board help system
    - h. Extensive, searchable fixture library with support for RDM fixture discovery
    - i. Two configurable security levels for user access and setup

THEATRICAL LIGHTING AND CONTROL SYSTEM

- j. Adjustable time out options including: dim, off, or user selectable inactivity image
3. Functional - Timeclock
- a. Home screen displays time and date
  - b. Supports 80 real time or astronomical events
  - c. Configurable open and close hours per day
  - d. Ability to hold current preset for timed-event override (up to two hours)
  - e. Supports every day, weekday, weekends and day of week recurrence
  - f. Supports Time-of-day, sunrise with offset, and sunset with offset events
  - g. Powerful state-based programming tool
  - h. Supports up to 16 control spaces
  - i. Resumes program automatically after power loss
4. Protocols
- a. Support for DMX (ANSI E1.11), RDM (ANSI E1.20), sACN (ANSI E1.31), Art-Net, and EchoConnect protocols
  - b. Support for up to 512 simultaneous addresses using any combination of output protocols
  - c. EchoConnect output of up to 16 zones per space
  - d. Connects to EchoConnect station bus for use with all Echo control and output products
5. Mechanical
- a. 7 in color multi-touch touchscreen with adjustable backlight
  - b. 800 x 480 screen resolution
  - c. Cast aluminum bezel finished in fine textured powder coat paint available in four standard colors:
    - 1) Provide finish as directed during shop drawings.
  - d. No visible means of attachment
  - e. Flush-mount to industry standard 3-gang back box (RACO 697 or equivalent)
  - f. Back box for surface mount applications available from ETC
  - g. Locking cover available
6. Electrical
- a. RJ45 connector compliant with IEEE 802.3i for 10BASE-T, and 802.3u for 100BASE-TX
  - b. Powered using 802.3af for Power over Ethernet
  - c. Pluggable rising clamp screw terminal connector for Auxiliary Power and EchoConnect wiring
  - d. Pluggable rising clamp screw terminal or IDC connector for DMX wiring
  - e. USB port for firmware maintenance, file transfer, and show file storage
  - f. Power draw up to 750 mA
  - g. A stand-alone 24 V Auxiliary Power Supply is available for use with EchoTouch when PoE is not used:
    - 1) Model APS2, knockout-mount, provides 1,300 mA of power and supports one EchoTouch plus two Echo accessory devices
    - 2) Model PS435, DIN rail mount, provides 2,000 mA of power and supports two EchoTouch plus two Echo accessory devices

THEATRICAL LIGHTING AND CONTROL SYSTEM

7. EchoConnect
  - a. Connects via two-wire EchoConnect control network using low-voltage Class 2 wiring
    - 1) Topology-free wiring over Belden 8471 or equivalent and one #14 ESD drain wire
  - b. Supports use of Belden 1583A or equivalent Ethernet control wire when used with IDC termination kit
  - c. Wiring may be bus, loop, homerun, or any combination of these
  - d. Supports up to 500 m (1,640 ft) of control wiring
    - 1) Up to 300 m (1,000 ft) using Cat5
8. DMX
  - a. Connector designed for use with Belden 9729 (or equivalent)
  - b. Optional header included for use with Belden 1583A (or equivalent)
  - c. Fully optically isolated from controller electronics
  - d. Withstands fault voltages up to 250 VAC
9. Thermal
  - a. Ambient temperature: 0°–40° C (32°–104° F)
  - b. Ambient humidity: 5–95% non-condensing
- E. Provide the following:
  1. 1 – Control console as specified above.
    - a. 1 - 25' control cable set.
    - b. Console control receptacles where indicated on drawings.
  2. Stage Manager's Panel as specified above.
- F. DMX Distribution
  1. Provide a completely wired DMX system, with DMX jacks at each of the front of house bar(s), tormentors, stage electrics, stage boxes, wall pockets, etc.

2.7 FINISHES

- A. Manufacturers' standard, unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment according to the manufacturer's written instructions. Set permanently mounted items plumb and level and square with ceilings and walls.

THEATRICAL LIGHTING AND CONTROL SYSTEM

- B. Mounting of Equipment: Conform to manufacturer's instructions and Division 26 Section "Supporting Devices". Mounting heights indicated are to bottom of unit for suspended items and to center of unit for wall-mounted ones.
- C. Provide miscellaneous power as required from the nearest 120/208V panel.

3.2 CONTROL WIRING INSTALLATION

- A. Install wiring between control devices as specified in Division 26 "Wires and Cables – 600V and Below" for hard-wired connections. Install wiring in raceway except cable and plug connections.
- B. Wiring in Enclosures: Bundle, train, and support.

3.3 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
- B. Label each luminaire, lighting outlet, distribution device, and dimmer module with unique designation. Labels on elevated components shall be readable from the floor.

C. FIELD QUALITY CONTROL

- D. Manufacturer's Field Services: Arrange and pay for the service of a factory-authorized service representative to test, adjust, and program the lighting control system.
- E. Schedule visual and mechanical inspections and electrical tests with at least 21-days advanced notification.
- F. Electrical Tests: Perform according to manufacturer's instructions. Exercise caution when testing devices containing solid-state components.

3.4 CLEANING AND ADJUSTING

- A. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars of finish to match original finish. Clean fixtures, devices, and equipment internally and externally using methods and materials as recommended by manufacturers.

3.5 DEMONSTRATION

- A. Demonstrate the system to prove compliance with requirements.
- B. Direct Training: Arrange and pay for the services of a factory-authorized service representative to demonstrate the lighting control system and train the Owner's personnel.
  - 1. Conduct a minimum of 2 days of up to 8 hours of training each time in operation and maintenance to allow training of multiple groups of people. The training is to include system operation and maintenance procedures.
  - 2. Schedule each day of training at least two (2) weeks apart.
  - 3. Schedule training with at least a 21-day advance notification.

3.6 COMMISSIONING

- A. Operational Tests: Energize lighting controls systems, program controls, and check controlled outlets for light levels.
- B. Correct deficiencies and retest deficient items. Verify by the system tests that specified requirements are met.

3.7 ADDITIONAL DEMONSTRATION/COMMISSIONING

- A. Included in the bid, shall be an additional demonstration/commissioning visit that shall consist of a single minimum four (4) hour visit, six (6) to twelve (12) months after substantial completion. This visit shall comprise of additional training on the lighting console and dimmer rack, as well as programing changes as requested by the owner.

END OF SECTION 26 55 61