SECTION 26 53 00
THEATRICAL LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and all connections of the Theatrical Lighting System.

1.2 RELATED WORK

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

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATION.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For stage lighting. Show fabrication and installation details for dimmer racks, including arrangements, characteristics, and circuit assignments of various modules. Include elevation views of front panels indicating devices and controls. Include illustrations and dimensioned outline drawings.

1. Wiring Diagrams: For power, signal, and control wiring. Show connections and circuit and channel assignments.
2. Equipment Legend: Show a unified system of designations for lighting instruments, panels, dimmers, circuits, and equipment.

C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around dimming equipment where piping and ducts are prohibited. Show rack layout and relationships between components and adjacent structural and mechanical elements.

D. Qualification Data: For qualified Installer.

E. Field quality-control reports.

F. Operation and Maintenance Data: For fixtures, distribution components, software operating manuals and controls 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. Control-Console Introduction:

    a. Descriptions of controls and features.
    b. Software instruction manuals.
    c. Setup requirements for unit and related equipment.
    d. Default settings.
    e. Maintenance procedures and schedules.

2. Control-Console Operation:

    a. Elementary on-off operation.
    b. How to set cues manually.
    c. How to patch dimmer to channels electronically.
    d. How to operate two-scene presets manually.
    e. How to operate fundamental memory.
    f. How to set and record simple cues.
    g. How to recall, play back, and revise cues and scenes.
    h. How to use submasters, and how to split cues, store and recall programs, set up special effects, and print out cues.
    i. How to set up and run system for a typical event or performance.
    j. How to get help.

3. Dimming Racks:

    a. Descriptions of features, functions, and safety and security precautions.
    b. Descriptions of dimmer module features, dipswitches, non-dim functions, and racking systems.
    c. How to check loads against dimmer capacity ratings.
    d. How to set basic power-in and power-out connections.
    e. Basic maintenance requirements, including need for qualified electrician for internal maintenance; basic maintenance schedule; techniques for keeping terminals properly tightened, filter screens clean, and overheat sensors checked; and techniques for performing other required servicing.
    f. How to adjust control cards.
    g. How to get help.
    h. Description of warranty.

4. System Troubleshooting: Procedures for handling problems with common software, programming, control console, dimmer rack, and distribution system; include information on how to get help.
5. Lighting fixture relamping, accessories list, and safety instructions.

G. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list if applicable.
4. Printout of software application and graphic screens.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

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 NECA 1.

D. Comply with NFPA 70.

1.6 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

PART 2 - PRODUCTS

2.1 PLUG CONNECTORS

A. Pin Type: USITT S3, two-pole, three-wire, 20-A.

B. Twist-Locking Type: NEMA WD 6, two-pole, three-wire, 20-A.

2.2 LIGHTING FIXTURES AND ACCESSORIES

A. General:

1. Comply with UL 1573 and listed and labeled by an NRTL.
2. Fixtures: Equipped with pigtail, yoke with pipe clamp, safety cable for batten mounting, and filter holder.
3. Metal Parts: Free of burrs, sharp corners, and edges.
4. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
5. Fixture Doors and Their Internal Access: Smooth operating, free of light leakage under operating conditions, and arranged to permit relamping without use of tools. Doors, lenses, diffusers, and other pieces arranged to prevent accidental falling during relamping and when secured in operating position.
6. Pigtail: Factory wired, 36-inch- (900-mm-) long, three-wire cord and plug connector assembly with cord encased in woven fiberglass or silicone tubing.
7. Lamp Sockets: Relampable without disturbing alignment or focus adjustment.
8. Fixture Ventilation Openings: Baffled against light leaks.
9. Fixture Operating Controls and Handles: Thermally insulated.
10. Lenses: Borosilicate glass in silicone mountings.
11. Framing Shutters: Stainless steel, four way; with each blade in a separate plane under adjustable tension mounting. Blades

adjust plus or minus 30 degrees of rotation in gate, for 120-degree-minimum total angular rotation between adjacent blades.

12. Color Filter Frame Holder: Attached to front of fixture.
13. Fixture Yoke: Rigid metal, arranged for vertical aiming of unit and equipped with T-bolt or hand screw to lock alignment.

B. Ellipsoidal Spotlights: Fixtures with an elliptical reflector mounted in a fixed relationship to the lamp. Light shall be projected through a gate where the beam is shaped by using shutters, a gobo, or an iris. The shaped beam shall then be focused by a system of lenses.
   a. Pattern Holders: Three for each fixture, with framing shutters.
   b. Color Frame: Black, metal.
   c. Minimum Cosine Illumination Performance Ratings When Operated with ANSI C78 Series, FEL Lamp:

      1) 171,000 beam candlepower at 20-degree field angle.
      2) 48,000 beam candlepower at 40-degree field angle.

C. Zoom Ellipsoidal Spotlights: Fixtures with an elliptical reflector mounted in an adjustable relationship to the lamp. Light shall be projected through a gate where the beam is shaped by using shutters, a gobo, or an iris. The shaped beam shall then be focused by a system of lenses.
   a. Pattern Holders: Three for each fixture, with framing shutters.
   b. Operator adjustable from 25- to 50-degree field angle.
   c. Field-angle adjustment scale label on instrument housing for field reference.
   d. Minimum Cosine Illumination Performance Rating When Operated with ANSI C78 Series, FEL Lamp: 82,000 beam candlepower at 35-degree field angle.

D. Fresnel Lens Spotlights:

   1. Die-cast extruded-aluminum housing, with hinged front for relamping.
      a. Lens: 6 inches (152 mm).
      b. Illumination Performance Rating When Operated with ANSI C78 Series, EGT Lamp:

         1) 175,000 beam candlepower at 12.5-degree field angle in spot focus.
         2) 12,000 beam candlepower at 74.6-degree field angle in flood focus.

      c. Barn Doors: Two 4-leaf rotatable metal flaps for every three fixtures.

E. PAR Lamp Holders:
   a. Housing: Steel or aluminum with porcelain-plated shell socket.
   b. Housing: Steel or aluminum, with porcelain-plated shell socket.
   c. Barn Doors: Two 4-leaf rotatable metal flaps for every three fixtures.

d. With Lens Holder and Replaceable Lenses:

F. Borderlight Units:

1. Front Door: Spring loaded; designed to hold either filter frames or color roundels.

2. Color Roundels: One for each lamp; Hanger: Adjustable, steel-strap type equipped at each end with pipe clamp and safety cable for suspension from a batten.

G. Cyclorama Lights: Suitable for lighting cycloramas from above.
a. Housing: Aluminum

2.3 DISTRIBUTION COMPONENTS

A. Connector Strip: Listed and labeled by an NRTL; factory-wired wireway and receptacle assembly.

1. Wireway: Steel or extruded aluminum, with removable cover and nominal cross-section dimensions of 3 by 4-1/2 inches (75 by 115 mm).
2. Accessories: Cable clamps, support cradles, and cable strain relief grips for each cable.
3. Receptacles: Pigtail mounted, 18 inches (450 mm) long, with strain relief at wireway wall penetration.
4. Receptacles: Flush mounted in wireway cover.
5. Receptacle Wiring: For connecting to terminal blocks; with 125 deg C, crosslinked, PE-insulated, identification-labeled wire.
6. Terminal Blocks: Molded-barrier type with screw lugs to suit supply conductors.
7. Mounting Hardware: Furnished with each unit; permits surface, single-pipe-bracket, or double-pipe-bracket mounting.
8. Finish: Semigloss or matte black.

B. Plug-in Boxes: Listed and labeled by an NRTL; factory-wired wireway and receptacle assembly, 24 inches (600 mm) long unless otherwise indicated; with the following features:

1. Wireway: Steel or extruded aluminum, with removable cover and nominal cross-section dimensions of 3 by 4-1/2 inches (75 by 115 mm).
2. Accessories: Cable clamps, support cradles, and cable strain relief grips for each cable.
3. Receptacles: Pigtail mounted, 18 inches (450 mm) long, with strain relief at wireway wall penetration.
4. Receptacles: Flush mounted in wireway cover.
5. Receptacle Wiring: For connecting to terminal blocks; with 125 deg C, crosslinked, PE-insulated, identification-labeled wire.
6. Terminal Blocks: Molded-barrier type with screw lugs to suit supply conductors.
7. Surface or Grid Mounting: With accessories for surface mounting or with pipe-mounting accessory bracket.
8. Recessed Mounting: With flanged cover suitable for recessed mounting in wall.

9. Finish: Semigloss or matte black.

C. Gridiron Junction Boxes: Listed and labeled by an NRTL; factory wired with terminal strips and concentric knockouts on all sides.

1. Terminal Blocks: Molded-barrier type with screw lugs to suit supply conductors.
2. Accessories: Cable clamps, support cradles, and cable strain relief grips for each cable, and brackets for surface or pipe mounting.
3. Finish: Semigloss or matte black.

D. Floor Pockets: Listed and labeled by an NRTL; flush-mounted, receptacle outlet assembly.

1. Box: 0.0598-inch (1.5-mm) steel sheet, 10 inches (250 mm) deep.
2. Cover Plate: Steel, cast iron, or cast aluminum with nonskid safety tread surface and self-closing, hinged door with cable notches.
3. Barrier for allowing installation of low-voltage control receptacle for console input or handheld remotes.

2.4 WIRE AND CABLE

A. Building Wire in Raceways: Comply with requirements specified in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Portable Power Cable: Listed and labeled by an NRTL; flexible stage and lighting power cable; Type SC, SCE, or SCT; 600 V; multiconductor; 60 deg C temperature rating.

C. Ethernet Cabling: Comply with requirements specified in Division 26 Section "Control-Voltage Electrical Power Cables."

1. For 10/100BaseT, comply with provisions for UTP cable and hardware.

D. ANSI E1.11 (USITT DMX512-A) Control Cabling: Comply with requirements specified in Division 26 Section "Control-Voltage Electrical Power Cables."

1. Standard Cable: NFPA 70, Type CM.

a. Paired, low-capacitance computer cable for ANSI E1.11 (USITT DMX512-A) applications. Two pairs, twisted, No. 22 AWG, stranded, tinned-copper conductors.
b. PE insulation.
c. Inner Shield: 100 percent coverage, aluminum foil-polyester tape.
d. Outer Shield: 90 percent coverage, tinned-copper braid.
e. Outer Shield Drain Wire: Stranded, tinned copper.
f. PVC jacket.
g. Flame Resistance: Comply with UL 1581.

E. Low-Voltage Control Cabling:

1. Paired Cable: NFPA 70, Type CMG.

a. One pair, twisted, No. 16 AWG, stranded, tinned-copper conductors.
b. PVC insulation.
c. Unshielded.
d. PVC jacket.
e. Flame Resistance: Comply with UL 1581.

2. Paired Cable: NFPA 70, Type CMG.

a. One pair, twisted, No. 18 AWG, stranded (19x30), tinned-copper conductors.
b. PVC insulation.
c. Unshielded.
d. PVC jacket.
e. Flame Resistance: Comply with UL 1581.

2.5 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 UL 508.

B. Dimmer Racks: Listed and labeled by an NRTL; dead-front, front-access, freestanding rack for mounting modular dimmers; formed-steel or extruded-aluminum structural members; completely enclosed with steel or aluminum panels. Painted with manufacturer's standard corrosion-resistant primer and finish coats, and having the following features:

1. Primary Circuit Breaker: Fault-current withstand rating of the rack; not less than 10,000 A, symmetrical.
2. Hinged, locking front door, with openings to allow air intake across the face of all dimmer modules.
3. Individual rack sections shall not exceed 84 inches high by 25 inches deep by 30 inches wide (2134 mm high by 635 mm deep by 762 mm wide). Multisection racks shall be interconnected with busbars.
4. For each module position, provide support rails and control-pin configurations, constructed for precise alignment of dimmer modules into power and signal connector sockets.
5. Forced-air cooling of each rack for maintaining operating temperature at each dimmer, assuming full load, in ambient temperature not to exceed 40 deg C. Exhaust rates shall be variable, using temperature sensors and fan-speed control electronics. Individual control of multiple fans is acceptable in lieu of fan-speed control. Fan(s) shall start and stop automatically. Fan noise at full load shall be less than 3.1 sones.

6. Each rack shall have an automatic air-temperature sensor to shut off all dimmers in the rack should the internal temperature rise above maximum safe operating limits. In an overheat condition, the fan shall continue operating. When a safe operating temperature is restored, the system shall automatically reset to allow normal user control.
7. Fabricate and test dimmer racks to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Dimmers: Modular solid-state units that operate smoothly over their operating ranges without audible lamp noise or radio-frequency interference at any setting. Modules shall be dead-front, draw-out type with floating line, load, and control sockets for smooth insertion and withdrawal; with load-side thermal-magnetic circuit breaker, speed-controlled cooling fan, and overtemperature sensor.

1. Non-Dim Units: On-off relay control only. Capable of serving inductive loads such as motors or high-intensity-discharge fixtures.
2. Surge Protection: Modules shall withstand power-line surges of 6000 V/3000 A according to IEEE C62.41.1 and IEEE C62.41.2.
3. Filter each dimmed circuit to provide a minimum 350-mic.sec., current-rise time at a 90-degree conduction angle at 50 percent of rated dimmer capacity. At any load within rating, rate of current rise shall not exceed 30 mA/mic.sec., measured from 10 to 90 percent of load current waveform.

D. Control System: Microprocessor-based control system, ANSI E1.11 (USITT DMX512-A) protocol, with a nonvolatile system memory to adjust dimmer channel settings for different scenes, to patch dimmers to channels, and to manually or automatically change dimmer settings from one preset scene to another.

1. Control shall support Ethernet-based LAN at every control device.
2. Provide means to create and monitor show data on a PC using software by console manufacturer. Software shall be capable of the following:

    a. Creating show and providing for use of USITT show files.
    b. Playing back show in a console-simulation mode.
    c. Accessing all remote-control stations associated with the console and control system.
    d. Providing standard Ethernet connection between the console control system and the PC.

E. Control Console: Tabletop unit with manual and computer-based programming controls, memory units, indicating devices, and the following features:

1. Servicing access through hinged top panel.
2. Grand-master level control.
3. Blackout switch.
4. 12 submaster level controls with overlapping pile-on performance.
5. 24 submaster level controls with overlapping pile-on performance.

6. Bump buttons for momentary control of channels or submasters, one for each submaster level control.
7. Two cross-fade controls for split dipless fade between scenes, each with its own fade progress indicator.
8. One set of scene level controls for each scene when used in two-scene preset mode. Second set of scene level controls to allow setting levels into memory for expanded single scenes when used in multiple single-channel scene mode. Each set shall have same quantity of scene level controls as is used for submaster level controls.
9. Multibutton keypad for programming in multiscene memory mode.
10. Fade time control for assigning fade time to cues, with individual cue adjustment from one second to five minutes, minimum.
11. LCD with associated display controls, for displaying operating menus and memory readout.
12. Controls for setting levels into memory.
13. Cord and connector for connecting console to outlets for console power and control.

F. System Operation: Selectable between multichannel two-scene preset and four-channel single-scene memory. Console features include electronic patching of control signals for up to 512 dimmers and off-line data storage using internal, 3-1/2-inch (90-mm) disk-drive unit. Operational capability includes the following:

1. Live and blind programming.
2. Special effects programmability for automatic operation of lights in pulsating, sequential dimming and brightening, and other special operating modes. Special effects menu displays operator guidance for programming and individual step levels.
3. Signal from fire-alarm control panel that automatically brings selected circuits to fully on or fully bright condition, overriding normal dimming and on-off controls.
4. Inserting cues between designated cues without renumbering.
5. Out-of-sequence playback of cues.
6. Controlling houselights and stage lights from console by assigning their dimmers or non-dim on-off controls to a channel.
7. Retaining programmed cues in memory for minimum of one year after power outage.
8. Automatic sequential execution of programmed cues.
9. Printing cues using parallel or serial printer port, cable, and printer. Cable and printer are not included with this system.
10. Keyboard: With a minimum of 64 characters; standard ASCII character set based on ANSI INCITS 154 (formerly ANSI X3.154).

11. CD-ROM Drive: 24x/10x/24x CD-RW/8x DVD combination.

G. Console Power and Control Outlets: Multiple receptacles matched to connector on console connector cord.

H. House Lighting Control Station: Architectural-type, multichannel, remote-dimmer-control station with the following features:

1. System controls designated houselights, stage lights, and other lights.

2. Stage lighting controls compatible with dimming and control system.
3. Flush mounting.
4. Brushed-aluminum wall plate.
5. Six channels, each with slider potentiometer control.
6. Master-slider potentiometer that controls lights on all channels proportionally from completely dimmed to degree of brightness that corresponds to individual slider positions.
7. Fully on switch that turns all channels on at full brightness regardless of slider position.
8. Take-control/off switch that places station in control of channels and sets lighting to levels dictated by channel and master-slider controls.
9. Legend on face of wall plate that identifies items as "House Lighting Control Station" and identifies functions of each slider and switch position, with slider positions individually graduated from zero to 10.
10. Flush wall mounted unless otherwise indicated.

I. Entry Station: Push button activates or deactivates indicating light and presets scene of house lighting control system.

1. Light-emitting-diode indicating light illuminates when preset command is executed.
2. Labeled "Entry."
3. Flush wall mounted unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set permanently mounted items level, plumb, and square with ceilings and walls.

B. Indicated mounting heights are to bottom of unit for suspended items and to center of unit for wall-mounted items.

C. Mount and connect fixtures, and install and connect distribution devices.

1. If arrangement is not indicated, install so each fixture, dimmer, house lighting circuit, control channel, and outlet circuit can be operated, and complete system demonstrated, in all operating modes.
2. Install safety cables secured to stage rigging or gridiron for all pipe-mounted electrical fixtures and equipment.

3.2 WIRING

A. Power Wiring:

1. Install wiring as specified in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables" for hardwired

connections. Install wiring in raceways except cable and plug connections.

2. Install power wiring with a separate neutral for each output circuit from main dimmer and for each house and stage lighting circuit.

B. Signaling, Remote-Control, and Power-Limited Circuits:

1. Comply with the following unless otherwise indicated:

   a. Size conductors according to lighting control device manufacturer's written instructions.
   b. Select cable insulation, shielding, drain wire, and jacket complying with lighting control device manufacturer's written instructions.
   c. Install circuits to eliminate radio-frequency interference and electromagnetic interference.

2. Remote-control circuits associated with emergency lighting control shall be installed complying with Class 1 Circuit standards in NFPA 70.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes and in terminal cabinets and equipment enclosures.

E. Remove wall plates and protect devices and assemblies during painting.

F. Support lighting fixtures, distribution components, and accessories as specified in Division 26 Section "Hangers and Supports for Electrical Systems." Equip all pipe-mounted equipment with safety cables that are secured to supporting pipe.

G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.3 IDENTIFICATION

A. Identify components, power, and control wiring according to Division 26 Section "Identification for Electrical Systems."

B. Label each fixture, lighting outlet, distribution device, and dimmer module with unique designation. Labels on elevated components shall be readable from the floor.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. 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.

C. Tests and Inspections:

1. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.
2. Visual and Mechanical Tests and Inspections:

    a. Inspect each fixture, outlet, module, control, and device for defects, finish failure, corrosion, physical damage, labeling by an NRTL, and nameplate.
    b. Exercise and perform operational tests on mechanical parts and operable devices according to manufacturer's written instructions.
    c. Check tightness of electrical connections with torque wrench.
    d. Verify proper protective device settings, fuse types, and ratings.
    e. Record results of tests and inspections.

3. Electrical Tests: Perform tests according to manufacturer's written instructions.

    a. Continuity tests of circuits.
    b. Operational Tests: Connect each outlet to a fixture and a dimmer output circuit so each dimmer module, dimmer control and output circuit, outlet, and fixture in a typical operating mode will be sequentially tested. Set and operate controls to demonstrate fixtures, outlets, dimmers, and controls in a sequence that cues and reproduces actual operating functions for a typical system of the size and scope installed. Include operation and control of houselights and stage lights from each control location and station including optional plug-in, control-console outlet locations. Record fixture and outlet assignments, control settings, operations, cues, and observations of performance.

4. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible organization and individual.

D. Stage lighting will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

1. Prepare a schedule of lighting outlets by number; indicate circuits, dimmers, connected fixtures, and control-channel assignments. Prepare a schedule of control settings and circuit assignments for house control channels. Prepare written reports of tests and observations. Report defective materials, workmanship, and unsatisfactory test results. Include records of repairs and adjustments made.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain stage lighting equipment.

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