

SECTION 26 51 00

INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, "Electrical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: The extent of lighting fixture work is as shown and scheduled, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications. All materials, accessories, and any other equipment necessary for the complete and proper installation of all lighting fixtures included in this Contract shall be furnished by the Contractor.

VERIFY TYPES

- B. Types: The types of lighting fixtures required for the project may include, but are not limited to:

1. Fluorescent fixtures.
2. High-intensity-discharge (HID) fixtures.
3. Incandescent fixtures.
4. **Cold cathode lighting.]**
5. **Custom lighting fixtures.]**
6. Exit signs.
7. Fluorescent emergency battery pack units.

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- C. Applications: The applications of lighting fixtures required for the project include, but are not limited to:

1. General lighting.
2. Specialty lighting.
3. Emergency, egress and exit lighting.

- D. Specifications and scale drawings are intended to convey the salient features, function and character of the fixtures only, and do not undertake to illustrate or set forth every item or detail necessary for the work.
- E. Minor details, not usually indicated on the drawings nor specified, but that are necessary for the proper execution and completion of the fixtures, shall be included, the same as if they were herein specified or indicated on the Drawings.
- F. The Owner shall not be held responsible for the omission or absence of any detail, construction feature, etc. which may be required in the production of the fixtures. The

responsibility of accurately fabricating the fixtures to the fulfillment of this specification rests with the Contractor.

1.3 STANDARDS:

- A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:
 - 1. NFPA 101 Code for Safety to Life from Fire in Buildings and Structures.
 - 2. NEMA WD1 General-Purpose Wiring Devices.
 - 3. ANSI C82.1 Specification for Fluorescent Lamp Ballasts.
 - 4. NEMA LE HID Lighting System Noise Criterion (LS-NC) Ratings.

1.4 QUALITY ASSURANCE:

- A. **Manufacturers:** Provide products produced by manufacturers as shown or scheduled for each type of lighting fixture. Identification in the fixture schedule by means of manufacturers' names and catalog numbers is to facilitate establishment of basic features, construction and performance standards. Any substitutions must, in the opinion of the Engineer **[and Lighting Consultant]**, meet or exceed these standards. **[All lighting fixtures with cone type reflectors shall be from the same manufacturer when fixtures are installed in the same room or area, to maintain consistency of reflector colors.]** Provide products complying with these specifications and produced by one of the following for ballasts, lamps, and battery back-up units:
 - 1. Ballast Manufacturers:
 - a. Advance Transformer Company.
 - b. Universal/Magnetek.
 - c. Osram/Sylvania.
 - d. Lutron.
 - 2. Lamps:
 - a. General Electric Company.
 - b. Osram Sylvania.
 - c. Phillips Lighting Corporation.
 - 3. Emergency Battery Back-up Units:
 - a. Bodine.
 - b. Chloride.
 - c. Lithonia.
- B. **CBM Label:** Provide fluorescent ballasts which comply with Certified Ballast Manufacturers' Association (CBM) standards and carry the CBM mark on the label.
- C. **Conformance:** Fixtures shall be manufactured in strict accordance with the Drawings and Specifications.
- D. **Codes:** Materials and installation shall be in accordance with the latest revision of the National Electrical Code and any applicable federal, state, and local codes and regulations.

- E. UL-listing: All fixtures shall be manufactured in strict accordance with the appropriate and current requirements of the Underwriters' Laboratories, Inc. "Standards for Safety," and others as they may be applicable. A UL-listing shall be provided for each fixture type, and the appropriate label or labels shall be affixed to each fixture in a position concealing it from normal view.
- F. Warranty: All ballasts shall be provided with a two (2) year parts and labor warranty from the date of project acceptance.

1.5 SUBMITTALS:

- A. Shop Drawings submittals shall include, but not be limited to, the following:
 - 1. Submit manufacturer's data on interior and exterior lighting fixtures in booklet form, with separate sheet for each fixture, assembled by fixture "type" in alphabetical order, with the proposed fixture and accessories clearly labeled. Ballast and lamp product data shall accompany fixture submittals. **[Submittals for custom fixtures shall include complete dimensioned fabrication drawings and descriptive text adequate to allow the proposed fixture materials and construction to be evaluated.]**
 - 2. Submit dimensioned drawings and performance data including coefficients of utilization, candela distribution, spacing to mounting height ratio, efficiency and visual comfort probability.
 - 3. Submit details of fixture mounting including frames, trims, canopies, support requirements, and other data pertinent to fixture installation.
 - 4. Submit complete photometric data for each fixture, including optical performance and efficiency rendered by independent testing laboratory developed according to methods of U.S.A. Illuminating Engineering Society as follows:
 - a. For down and semi-down lights used for general illumination: (1) Coefficients of utilization; (2) Visual Comfort Probability data (fluorescent only) for 100 footcandles, in a 20'by 20'room with 10'ceiling and luminaires lengthwise with reflectances of 80% (ceiling), 50% (walls), and 20% (floor); (3) Candlepower data, presented graphically and numerically, in 5 degree increments (0 degrees, 5 degrees, 10 degrees, etc.). If light output is only bilaterally symmetric, data also developed for up and down quadrants normal, parallel, and at 22-1/2 degrees, 45 degrees, and 67-1/2 degrees to lamps; and (4) Zonal lumens stated numerically in 10 degree increments and at angles to lamps as described above.
 - b. For area and roadway luminaires: (1) Isocandela charts; (2) Coefficients of utilization; and (3) IES roadway distribution classification.
 - c. [Supply photometric data as described above for any fixture offered in substitution for a specified fixture.]
 - 5. After shop drawing approval, and prior to release for manufacturing, the Contract shall furnish one sample of each fixture on the fixture schedule and contract drawings for which sample requirement is noted. Sufficient time shall be allowed for thorough examination of the samples by the Lighting Consultant. Samples shall be complete, ready for hanging, energizing, and examining, and shall be shipped, prepaid by Contractor, to the Lighting Consultant, or as otherwise advised. Samples are not returnable, nor included in quantities listed for a project. Samples must be an actual working unit of materials to be supplied.

6. Submit details of air handling provisions for fixtures with supply and return air capabilities including, but not limited to: Airflow capacities, pressure drops, boot and connection types and other pertinent data.
7. Additional information as required in Section 26 00 01, "Electrical General Provisions".

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver interior lighting fixtures individually wrapped in factory-fabricated fiberboard type containers.
- B. Handle interior lighting fixtures carefully to prevent breakage, denting and scoring the fixture finish. Do not install damaged lighting fixtures.
- C. Store interior lighting fixtures in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. General: Provide lighting fixtures, of the size, type and rating indicated on the Lighting Fixture Schedule, complete with, but not necessarily limited to, lamps, lampholders, reflectors, diffusers, louvers, wire guards, tube guards, ballasts, fuses, starters, and wiring. Fixtures shall be furnished with all required accessories and trim, including hold-down clips, as required for a complete installation in the ceiling-type shown on the Architectural Drawings.
 1. Lighting equipment shall be complete, wired, and including supporting means, such as plaster frames, supports, hangers, canopies, sockets, holders; current or voltage modifiers, such as ballasts, starters; light control materials; specifically diffusers, louvers, lenses, reflectors and refractors; and lamps.
 2. Lighting fixtures shall be designed for highest relative efficiency and service. Maintenance to be simple and relamping possible without use of special tools.
 3. Lighting fixtures shall be constructed and installed in accordance with local building codes and shall bear label of approved testing agent. Materials shall be new and of best grade of approved manufacturing standards. Workmanship shall be of highest order.
 4. Recessed fixtures shall be provided with frames appropriate construction encountered.
 5. Ferrous fixture components shall receive treating to assure corrosion resistance and paint adherence. Aluminum parts, unless made of alloys having inherent corrosion resistance, shall be anodized or coated with oxidation-preventing treatment. Finish shall be baked enamel where color is indicated.
 6. Plastic shall be acrylic.
- B. General Fixture Construction:
 1. All materials, accessories, and other related fixture parts shall be new and free from defects which in any manner may impair their character, appearance, strength, durability and function, and effectively protected from any damage or injury from the time of fabrication to the time of delivery and until final acceptance of the work.
 2. Fabricate fixture enclosures with a minimum of No. 22 gauge cold rolled sheet steel. Enclosures may be constructed of other metals, provided they are equivalent in mechanical strength, and acceptable to the Engineer[/**Lighting Consultant**].

3. All sheet metal work shall be free from tool marks and dents, and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. All intersections and joints shall be formed true of adequate strength and structural rigidity to prevent any distortion during shipping, installation, and while in normal use.
4. Housings shall be so constructed that all electrical components are easily accessible and replaceable without removing fixtures from their mountings, or disassembly of adjacent construction.
5. All custom light fixtures shall be thoroughly tested in Manufacturer's shop prior to shipment to ensure mechanical and electrical integrity.
6. All fixtures shall be completely wired at the factory.
7. If ceiling system requires, each recessed and semi-recessed fixture shall be furnished with a mounting frame or ring compatible with the ceiling in which they are to be installed. The frames and rings shall be one piece or constructed with electrically-welded butt joints, and of sufficient size and strength to sustain the weight of the fixture.
8. Fixture to be sealed against light leaks between ceiling trims of recessed and semi-recessed lighting equipment and the ceilings. If fixture is used in partially transparent ceiling, fixtures to be sealed against light leaks above the ceiling line.
9. Yokes, brackets and supplementary supporting members needed to mount lighting fixtures to carrier channels or other suitable ceiling members shall be provided as required.
10. Fixtures for use outdoors or in areas designated as wet locations shall be suitably gasketed to prevent the entrance of moisture. Provide approved wire mesh screens for ventilation openings. Damp location fixtures to be of corrosion resistant parts and hardware.
11. In the application and mounting condition specified, fixtures and ballasts must operate within the temperature limits of their design and as specified by Underwriters' Laboratories, Inc.
12. Each lighting fixture which has a beam angle adjustment shall have reliable angle locking device capable of long and continuous use.
13. Each lighting fixture which has a lamp with an oval shape beam pattern shall contain a lamp orientation locking device which will insure that beam orientation is not disturbed during lamp replacement and fixture cleaning.
14. Each light fixture which has a spread lens shall contain lens orientation locking device which will insure that lens orientation is not disturbed during lamp replacement and fixture cleaning.
15. All lamp sockets in lighting fixtures shall be suitable for the specified lamps and shall be set so that lamps are positioned in optically correct relation to all lighting fixture components. If adjustable socket positions are provided, socket should be preset in factory for the specified lamp . If different socket positions are specified for various types of the same fixture, sockets shall be preset for each type, and cartons marked accordingly.
16. **[All custom castings shall be exact replicas of the approved patterns and shall be free of sand pits, blemishes, scales and rust, and shall be smoothly finished.**

Tolerance shall be provided for any shrinkage of the metal, so that castings will accurately fit in their designated locations.]

17. **[If the contractor cannot fabricate a particular detail according to the drawings and specifications of the Lighting Consultant which is blemish-free and structurally strong, it is the responsibility of the Contractor to bring said detail to the attention of the Engineer/Lighting Consultant immediately.]**
18. **[All custom light fixtures shall be thoroughly tested by manufacturer prior to shipment to ensure mechanical and electrical integrity.]**

C. Reflectors and Trims:

1. Reflectors, reflector cones and visible trim of all lighting fixtures shall not be installed until completion of plastering, ceiling tile work, painting and general clean-up. They shall be carefully handled to avoid scratching or finger-printing and shall be, at the time of acceptance by the Owner, completely clean.
2. All Alzak parabolic cones shall be guaranteed against discoloration for a minimum of 10 years, and, in the event of premature discoloration, shall be replaced at the expense of the manufacturer for both materials and the cost of labor.
3. Aluminum reflectors shall be finished specular, semispecular, or diffuse as specified and shall meet or exceed Alzak specifications. Minimum requirements for reflector finishes for interior and exterior service shall be as follows:

<u>DESCRIPTION OF SERVICE</u>	<u>MINIMUM WEIGHT OF COATING MG. PER SQUARE INCH</u>	<u>MINIMUM PERCENT REFLECTANCE</u>	
		<u>SPECULAR</u>	<u>DIFFUSE</u>
Normal interior commercial service	5.0	83	75
General interior industrial and exterior work reflector protected by glass covering	7.5	82	73
Exterior industrial and commercial reflector not protected	10	78	75
Exterior marine service reflector not protected	13	78	65

D. Lenses:

1. Plastic for lenses and diffusers shall be formed of colorless 100% virgin acrylic as manufactured by Rohn & Haas, Dupont or as acceptable to the Engineer/[**Lighting Consultant**]. The quality of the raw material must exceed IES, SPI, and NEMA Specifications by at least 100% which, as a minimum standard, shall not exceed a yellowness factor of 3 after 2,000 hours of exposure in the Fade-meter or as tested by an independent test laboratory. Acrylic plastic lenses and diffusers shall be properly cast, molded or extruded as specified, and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for at least 15 years.
2. Glass used for lenses, refractors, and diffusers in incandescent and HID lighting fixtures shall be tempered for impact and heat resistance; the glass shall be crystal clear with a transmittance of not less than 88%. For exterior fixtures use tempered Borosilicate glass

Corning #7740 or as acceptable to the lighting consultant. For fixtures with a radiant energy of 4.16 watts per square inch or greater, directly exposed to the elements and aimed above the horizontal, use Vycor glass.

3. Where optical lenses are used, they shall be free from spherical and chromatic aberrations and other imperfections which may hinder the functional performance of the lenses.
4. All lenses, louvers, or other light diffusing elements shall be removable, but positively held so that hinging or other normal motion will not cause them to drop out.
5. All lenses shall be clean and free of dust at the time of substantial completion.

E. Lamp Holders:

1. Incandescent:
 - a. Body: Porcelain.
 - b. Screw Shell: Nickel-plated brass, prelubricated with silicone compound.
 - c. Contacts: Spring-loaded nickel-plated phosphor bronze.
2. Fluorescent:
 - a. Body: White urea plastic.
 - b. Contacts: Phosphor bronze.
3. High Intensity Discharge:
 - a. Body: Porcelain.
 - b. Screw Shell: Nickel-plated brass, prelubricated with silicone compound.
 - c. Contacts: Spring-loaded nickel-plated phosphor bronze.
4. Lamp holders in lighting fixtures shall be suitable for indicated lamps and shall be positioned to place lamps in optically correct locations in relation to fixture components. If adjustable socket positions are provided, socket should be present in factory for lamp specified. If different socket positions are specified for same fixture, sockets shall be preset for each type, and cartons marked accordingly.
5. Furnish lamp holders which are UL-listed and designed for proper lamp operation and life. Outdoor lamp-holders shall be neoprene-gasketed and compression type. Lamp holders to be appropriate to the specified lamp.

F. Finishes:

1. Painted Surfaces: Synthetic enamel, with acrylic, alkyd, epoxy, polyester, or polyurethane base, light stabilized, baked on at 350°F minimum, catalytically or photochemically polymerized after application.
2. White Finishes: Minimum of 85% reflectance.
3. Frames: Ceiling opening frames shall either be manufactured of nonferrous metal, or be suitably rustproofed after fabrication.
4. Selection: Unless otherwise noted, finishes shall be as selected by the Architect.
5. Undercoat: Except for stainless steel, provide ferrous metal surfaces with a five stage phosphate treatment or other acceptable base bonding treatment before final painting **[and after fabrication]**.

6. Unpainted Surfaces: Unpainted nonreflecting surfaces shall be satin-finished and coated with a baked-on clear lacquer to preserve the surface. Where aluminum surfaces are treated with an anodic process, the clear lacquer coating may be omitted.
7. Unpainted Aluminum Surfaces: Finish interior aluminum trims with an anodized coating of not less than 7 mg per square inch, of a color and surface finish as selected by the Architect. Finish exterior aluminum and aluminum trims with an anodized coating of not less than 35 mg per square inch, of a color and surface finish as selected by the Architect.
8. Porcelain Enamel Surfaces: Apply porcelain finishes smoothly. Finish shall be not less than 7.5 mils thick of non-yellowing, white, vitreous porcelain enamel with a reluctance of not less than 85%.

G. Fixture Fabrication:

1. General: Design components to allow for expansion and contraction for a minimum ambient temperature range of 150°F (37.8°C) without causing buckling, excessive opening of joints or over-stressing of welds and fasteners.
2. Sheet Metal Work: Form metalwork to required shapes and sizes with true curves, lines, and angles. All sheet metal work shall be free from tool marks and dents, and shall have accurate angles bent as sharp as compatible with the gauges of required metal. Form intersections and joints true with adequate strength and structural rigidity to prevent distortion after assembly. Provide necessary rebates, lugs and brackets for assembly of units. Use concealed fasteners wherever possible.
3. **[Castings: All castings shall be exact replicas of approved patterns and shall be free of sand pits, blemishes, scales and rust, and shall be smoothly finished. Tolerance shall be provided for any shrinkage of metal castings in order that finished castings will accurately fit in their designated locations.]**
4. Welding: Comply with AWS for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded joints of all welded flux and dress on all exposed and contact surfaces.
5. Assembly: Accurately fit all parts of fixture. All joints in metal, not checked, shall be brazed and not soldered. Joints shall be invisible. Where screws are necessary for adjustment of applied ornament, they shall be concealed, as far as possible, and finished to match other metalwork. Mill joints to a tight, hairline fit. Cope or miter corner joints. Form joints exposed to weather to exclude water penetration. Assembled fixtures shall be well braced, and of adequate strength to resist sagging or deforming.

H. Glass:

1. Glassware shall be mechanically strong, properly annealed, and free from internal strain that might cause breakage. Where possible glassware shall be tempered for impact and heat resistance. Unless otherwise noted, all enclosing globes shall match glass of existing fixtures, or if none exists, glassware shall match approved prototype in size, contour, finish and general appearance. Supplied globes shall faithfully reproduce existing globes or approved prototypes in every way, having qualities equal to or better than the approved prototype without sacrifice of any other characteristics such as transparency or translucency and reflection/refraction properties. Glassware supplied shall be of consistently high quality and free from such imperfections as streaks, corns, stones, blisters, checks or other flaws that affect glassware strength or appearance.

2. Dimensional Tolerances of Glass: All other dimensions of supplied globes shall not vary more than 1% more or less than the respective dimension on the approved prototype. Tolerances for glass thickness shall be set by the Architect and adhered to by the contractor. Each unit of glassware supplied shall be identical to others of that type and faithful to the approved prototype.
3. All glass ornament in relief and globes shall be blown up fully in molds so as to faithfully replicate approved samples.
4. Where shown, etch, chase or carve ornament on globes as detailed.
5. Glass Overage: Furnish 10% additional in number of each size and kind of globe (or a minimum of two, whichever is greater).

I. Wiring:

1. Generally use SF-2 insulated wire for rewiring existing or new wire at replicated light fixture. SF-1 may be substituted in those locations where space will not permit the installation of SF-2 and where the load is 6 amps or less. Provide 600 volt insulation.
2. Factory-wire all fixtures. Provide leads no shorter than 1'-0" or as required to suit the project application.

J. Connections:

1. Fasteners: Furnish fasteners of basic metal and alloy, matching finished color and texture as metal being fastened, unless otherwise indicated. For steel and aluminum fixtures, all screws, bolts, nuts, and other fastening and latching hardware shall be cadmium or equivalent plated. For stainless steel fixtures, all hardware shall be stainless steel. For bronze fixtures, all hardware shall be bronze.
2. Welding Materials: Type and alloy of filler metal and electrodes as recommended by producer of metal to be welded, and as required for color match, strength and compatibility in the fabricated units.

K. Fixture Types:

1. Fluorescent Fixtures: Provide fluorescent fixtures of the type scheduled on the Lighting Fixture Schedule, complete with ballasts and lamps of the type, color, wattage and size scheduled.
 - a. Provide fluorescent fixtures with heavy white lampholders with definite locking-in feature and contacts for proper lamp operation and life. Outdoor lampholders shall be neoprene gasketed and compression type. Sockets with open-circuit voltage over 300 volts to be safety type and designed to open the supply circuit on lamp removal.

[VERIFY THE FOLLOWING]

- b. Fixture body parts, comprising fixture housing, reflectors, wire channels, end plates, ballast housings, and similar body parts, shall be made of extruded aluminum, galvanized stampings, or bonderized steel, as indicated. Housing end plates, socket bridges, reflectors, wiring channels and ballast covers shall be die formed of not less than No. 22 gauge cold rolled steel unless specified otherwise. Mount lamps on rapid-start circuits within one inch (1") of grounded metal, one inch (1") wide minimum and as long as the lamp. Wireways shall have adequate wiring space, accessible after fixture installation. Construct fixtures so that ballast may be serviced or replaced without removal of fixture housing from adjacent construction. Housing

- shall be adequately ventilated where required. Hardware shall have rustproof finish. Fixture bodies shall be painted **[before] [after]** fabrication.
- c. Temperatures around ballast and in fixture housing shall not exceed 90°C with ambient room temperature at 27°C.
 - d. Lighting fixtures shall have continuous light-seal gaskets seated in such manner as to prevent any light leaking through any portion or around any edge of the trim frame. Other sealing methods shall be individually reviewed.
 - e. Diffusers shall be framed in hinged continuous assembly, except where frameless units are indicated. Frameless units shall be removable without tools and opened or closed by hand pressure. Diffuser frame latches shall be spring-loaded or cam-operated.
 - f. Fluorescent fixture lenses, where required, shall be 100% extruded virgin acrylic, prismatic-type, nominal 0.125" thick, unless specified otherwise. Provide a minimum of eight hold-down lens retaining clips for troffers utilizing framed diffuser lenses.
 - g. Fluorescent fixtures in continuous rows shall be supplied with all fixture couplings, chase nipples, and other accessories recommended by the manufacturer for continuous row installation.
 - h. Fluorescent troffers shall be shipped prelamp, unless noted otherwise.
 - i. Parabolic louver fluorescent troffers shall be shipped with a plastic bag or film to protect the louvers from site conditions. Louver protection shall not be removed until the space where the fixture is installed is complete.
 - j. Supply air-type fluorescent fixtures shall be provided with adjustable air pattern control blades.
 - k. Lay-in fixtures shall be provided **with hold-down clips** per the NEC, minimum two clips per fixture. Fixtures shall also be supported from the structure by two ceiling wires on diagonally opposite corners of the fixture.
2. HID Fixtures: Provide HID fixtures as scheduled on the Lighting Fixture Schedule, complete with fused ballast, lamps of the type, color, wattage, and size scheduled, or as specified by the lighting fixture manufacturer.
 - a. On open metal halide fixtures, provide a shield below the lamp to provide protection from lamp breakage at the end of lamp life.
 - b. Size and type of fuse shall be as recommended by the ballast manufacturer. Holders shall be mounted inside the fixture junction box for recessed fixtures, inside enclosed fixtures and inside pole base handholes of pole-mounted fixtures. Holders installed in damp or wet locations shall be waterproof. Holders installed in bollards and pole bases shall be of a breakaway disconnect design.
 3. Incandescent Fixtures: Provide incandescent fixtures as scheduled on the Lighting Fixture Schedule, complete with lamps of the type, color, wattage, and size scheduled.
 - a. Provide recessed incandescent fixtures with trim rings compatible with the ceiling material where fixture is to be installed. Incandescent fixtures shall be prewired equipped with integral thermal protection. Incandescent lighting fixtures shall be appropriately listed and labeled by Underwriters' Laboratories, Inc. for their final installation, i.e., damp or wet locations, etc.

- b. Recessed fixtures shall be designed and installed to eliminate light leakage.
 - c. Fixtures intended for use with medium or mogul base lamps shall use porcelain sockets, wire with (minimum) No. 18, 150°C rated wire and in accordance with the applicable NEC requirements. Fixtures intended for recessed mounting shall be furnished with not less than 4' of approved fixture wire. Lighting fixtures with PAR or similar lamps shall be wired with approved silicone or other approved fixture wire, suitable and labelled for the purpose.
 - d. Lampholders to be high grade porcelain, Edison screw-type, medium size and of the highest class and quality with socket of nickel-plated brass prelubricated with silicone compound. Provide mogul-type lampholders for lamps of 300 watt rating and over. Sockets shall be provided with an approved arrangement to securely set and lock socket into lighting fixture.
 - e. For recessed incandescent fixtures where junction box is required, shall be accessible when fixture is removed. Connect to conduit system with flexible conduit containing #14 (minimum) fixture wire.
 - f. Aluminum reflectors shall be Alzak (finish as selected) or as authorized, and not less than 0.057" thick, unless specified otherwise.
 - g. Incandescent lighting fixtures utilizing tungsten halogen sources shall be designed and constructed so that lamp seal temperatures do not exceed 350°C at an ambient temperature of 25°C when tested in accordance with UL Standard #57 and shall maintain an operating bulb wall temperature of approximately 600°C and not less than 250°C.
 - h. Lead wires for fixtures utilizing tungsten halogen sources shall be rated for not less than 200°C operation, but shall be rated for 250°C if expected temperature conditions warrant.
 - i. Temperature on reflectors shall not exceed 205°C at any point.
 - j. All fixtures specified for recessing in ceilings shall be supplied with prewired junction boxes.
4. Lighting Track: Provide a complete track lighting installation as scheduled on the Lighting Fixture Schedule, complete with fixture heads as shown or scheduled and lamps of the type, color, wattage and size scheduled.
- a. Lighting track shall be single circuit light track assembly unless specified otherwise. It shall consist of an outer housing with two electrical conductors, and with suitable insulation between the conductors and the housing. The conductors to be tin-plated copper and the insulation shall be of high temperature vinyl. The housing shall have a moment of inertia of not less than 0.160" and shall be made of a noncorrosive material such as an aluminum extrusion of Alloy 6063 T5.
 - b. Grounding may be provided by the housing or by other means, and in the process of installing a fixture on the track, the grounding connection shall be automatically completed before electrical conductor contact occurs. Maximum outside dimensions of the housing shall be 1-5/8" high x 1-7/8" wide with a continuous open slot on the ceiling line not wider than 3/4".
 - c. The track assembly shall be rated at not less than 50 amperes at 300 volts. The insulation shall be suitable and approved for temperatures resulting from the use of several track fixtures in close array with Q250 PAR 38 lamps. A special electrical

- feed box shall be furnished for attachment to any location along the track, with spring mounted coverplate fitting the box neatly and mounting flush with the conductors.
- d. The track shall be spliced in such a way that it is not obviously visible where the electrical and mechanical connection occurs.
 - e. Specially designed splice bars shall align and connect two runs of track.
 - f. Two push-in continuity jumpers shall be supplied to maintain electrical contact at a splice location. Track runs to be provided with 8" long #10 teflon leads.
 - g. The track shall incorporate means for secure mechanical attachment and simultaneous electrical feed of lighting fixtures equipped with the necessary attachment plug devices.
 - h. Recessed track as installed shall be absolutely flush with finished ceiling plane and absent of any gaps between ceiling material and aluminum housing. Contractor shall be responsible for making sure that recessed track integrates properly into ceiling construction and according to manufacturer's recommendations. This includes having appropriate ceiling assembly and finish material thickness.
5. Cold Cathode Lighting: Provide a complete cold cathode lighting installation as scheduled on the Lighting Fixture Schedule and as shown on the Architectural and Electrical Drawings and Details. It shall be manufactured in entirety, including lamps, lampholders and ballasts, by National Cathode Corp., or approved equal.
- a. Lamps shall be mounted in a straight electrode configuration and shall produce 440 lumens per foot when operating at 200 ma, and shall not depreciate more than 20% after 10,000 hours of operation.
 - b. Lamps shall be made from 1 inch (1") diameter lead glass halo-phosphor coated and baked, with heavy duty coated electrodes and shall be fabricated to the shapes and sizes called for in the Architectural details, and shall have adjustable snap-on lamp reflectors.
 - c. Lampholders shall be right-angle, straight electrode type, UL-listed, and of white glazed porcelain with spring bronze clip contacts to give good electrical contact and support the lamps securely.
 - d. Ballasts required for the cold cathode lamps shall be remotely located as directed by the Architect. The ballasts shall be UL-listed, HPF, 118 volt, 60 Hz, 200 ma, for cold weather operation.
 - e. Installation of lamps, lampholders, secondary feeds, and ballasts shall be in strict accordance with the intent of the contract drawings and the approved shop drawings of the cold cathode manufacturer. The Contractor shall install the lampholders so that all lamps make secure electrical contact.
 - f. Circuit breakers controlling the circuits feeding the cold cathode ballasts shall be capable of being locked in the open position.
 - g. Shop drawings shall include scale plans and details showing the method of installation of lampholders, lamps, reflectors, ballasts, and secondary feeds, as well as a complete bill of materials. The shop drawings shall show the exact locations of the lampholders and lamp shapes and lengths, and six copies shall be supplied, to be incorporated in the Maintenance Manuals.

- to provide maximum sound attenuation. **[Use of 3 lamp ballasts is acceptable unless dual level switching is shown on the drawings.]**
3. Ballasts - HID: Provide UL-listed or CSA-approved high power factor, constant wattage, regulated output/high reactance autotransformer ballasts with a -20°F temperature rating.
 - a. Fabricate core laminations of precision welded diecut high quality steel. Coils shall be of high temperature enameled magnetic wire and precision wound. Coils shall be constructed using materials suitable for operation at 180°C.
 - b. Capacitors shall be highest quality **[dry film] [or] [oil-filled]** type appropriate to the service intended. Outdoor ballasts shall use capacitors with 90°C temperature rating.
 - c. Recessed fixture ballasts shall be encapsulated or potted with solid fill with a maximum "B" sound rating. Surface and enclosed fixture ballasts shall be core and coil type with a maximum "C" sound rating.
 - d. Ballasts shall be mounted in or on lighting fixtures so as to provide maximum sound attenuation. Provide optional reduced noise ballast packaging where scheduled or shown on the Drawings.
 - e. Indoor mercury vapor ballasts shall be constant wattage autotransformer type with a power factor not less than 90%. Regulation: 13% variation in line voltage shall vary lamp watts by no more than _2%. Ballast shall sustain line voltage drop of 40% without extinguishing lamp.
 - f. Outdoor mercury vapor ballast shall be constant wattage autotransformer type with power factor of not less than 90%. Regulation: _10% variation in line voltage shall vary lamp watts by no more than _5%. Ballast shall sustain line voltage drop of 40% without extinguishing lamp.
 - g. Metal halide ballasts shall be constant wattage autotransformer type with lead peaked circuiting, and power factor of not less than 90%. Regulation: 10% variation in line voltage shall vary lamp watts not more than _10%. Ballast shall sustain line voltage drop of 35% without extinguishing lamp.
 - h. High pressure sodium vapor ballasts shall be the voltage stabilized autotransformer type with not less than 90% power factor. Regulation: 10% variation in line voltage will vary lamp watts not more than _3%. Ballast shall sustain line voltage drop of 20% without extinguishing lamp.
 - i. Where ballasts are remote mounted from lamps, ballast packs provided shall be capable of starting and operating lamps under the lamp/ballast separation and temperature conditions encountered in the installation proposed for the project.
 4. Dimming Ballasts: Wherever fluorescent or HID fixtures are to be dimmed, the fixture supplier shall coordinate the type of dimming ballast or pack to be used with the **[dimming] [lighting control]** equipment supplier to ensure compatibility. Magnetic dimming ballasts shall be factory-furnished and installed in light fixtures. **[Provide standard power factor ballasts for dimmed 26 watt compact fluorescent lamps.]** Solid state dimming ballasts and dimming packs shall be provided by the **[dimming] [lighting control]** equipment supplier and factory-installed in light fixtures. Dimmed fluorescent lighting fixtures shall be provided with circuit interrupting lampholders where required for the dimming ballast or pack being used.

M. Lamps:

1. General: Provide lamps of the wattage, type, color, and reflector lamps with type of beams indicated, as shown, and as scheduled. Provide extended service lamps that are inside frosted. Provide energy saving lamps for all fluorescent fixtures installed in indoor conditioned locations, unless otherwise noted. **[Provide standard, nonenergy saving lamps for all dimmed fluorescent fixtures.]** Incandescent and tungsten halogen lamps shall not be operated, other than for initial testing, prior to final inspection, or shall be replaced immediately prior to final inspection.
2. Maintenance Stock: Furnish a stock of replacement lamps in the original cartons or packing sleeves, amounting to 10% (but not less than two lamps in each case) of each type and size lamp used in each fixture type. Deliver replacement stock as directed to Owner's storage space.

N. Fluorescent Emergency Battery Backup Unit:

1. General: Provide fluorescent lighting fixtures with emergency battery backup and integral emergency (self-powered) fluorescent power system for each fixture as shown or scheduled on the Drawings. The integral fluorescent emergency power system shall consist of a charger, high frequency inverter, voltage disconnect and a sealed nickel cadmium battery designed for high temperature operation. Provide battery unit with self test feature.
2. Operation: During normal operation, when switched ac is present, the fixture will be fully illuminated by means of the regular ballast. At the same time, the emergency ballast is supplied with nonswitched ac, which transforms and rectifies into a low dc voltage to recharge the battery and maintain it in a fully charged condition. When the nonswitched ac fails, a solid state voltage sensor instantly turns on a high frequency inverter which illuminates one lamp in the fixture at reduced light output for a minimum of 90 minutes. At the end of the rated time a low voltage sensor disconnects the battery to prevent over discharging. When the ac nonswitched returns, the inverter switches off and the battery starts recharging.
3. Battery: (Internal) Sealed Nickel Cadmium - specially constructed to withstand the high temperatures of ballast compartments. 15 year life expectancy; 5 year unconditional and additional 5 year pro rata warranty. Batteries shall not require periodic cycling or full discharge upon use to maintain full battery capacity.
4. Power Requirements: 120 or 277 volts, 60 Hz, for the specified lighting fixtures as indicated on the Lighting Fixture Schedule.
5. Output: Suitable for one F40 fluorescent tube, rapid or instant start, operating at approximately 20% of its nominal light output.
6. Transfer: Solid state-type, automatically and instantly energizes lamp load upon failure of the ac supply. Battery protection circuit automatically shuts down lamp load when battery reaches full discharge.
7. Charger: All solid state, recharges battery in 12 to 24 hours, current limited and short circuit proof.
8. Inverter: All solid state, 87% minimum efficiency uses a fully isolated and protected electronic oscillator to produce an inaudible high frequency output. Inverter will ignite lamp which has burned out under normal conditions.

9. **Self-Test:** The diagnostic circuit continually monitors battery voltage and charging current, and will communicate a fault by flashing the status indicator lamp. An automatic discharge test is also performed for 30 seconds, every 30 days and for 90 minutes every 12 months.
10. **Enclosure:** 20 gauge steel painted black baked enamel. Mounts inside the fixture adjacent to normal ballast. Flying leads provided for connections to external test switch and pilot light which is supplied with the unit. Test switch and pilot light shall be furnished to the lighting fixture manufacturer for installation and connection into the fixture by the lighting fixture manufacturer.
11. **Warranty:** All electronics shall carry a 3 year unconditional warranty. The manufacturer of the unit shall provide three full cycles of discharge and recharge before shipment and shall certify that the testing has been done.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General:

1. Install lighting fixtures of the types indicated, where shown, and at the indicated heights in accordance with the fixture manufacturer's written instructions and recognized industry practices to ensure that the fixtures comply with the requirements and serve the intended purposes. Do not scale drawings for exact location of the lighting fixtures. In general, refer to the architectural reflected ceiling plans for proper locations of lighting fixtures. Fixtures shall exactly fit the type of ceiling system scheduled for the space.
2. Fixtures shown on the fixture schedule to be recessed shall be complete with plaster frames, mounting yokes, rod hangers, etc., and/or any other accessories required to fit the fixture to the ceiling construction. However, where ceiling system cannot maintain said support, fixture supports shall be provided and rigidly attached to the structural members of the building capable of carrying the weight of the fixture plus 200 pounds at each support without sagging. Provide the necessary supports for hangers located between structural members.

B. Standards: Comply with NEMA standards, applicable requirements of the NEC pertaining to installation of interior lighting fixtures, and with applicable portions of the NECA's "Standard of Installation".

C. Connection: All individual lay-in fluorescent fixtures in suspended ceilings, shall be connected back to the associated lighting grid outlet box by wire in 3/8" (minimum) flexible metallic conduit fixture-tails in lengths not to exceed 72"; or by Type MC cable fixture-tails where permitted by the local authority having jurisdiction, in lengths not to exceed 8'. All fixture tails shall have ground wire pulled with conductors.

D. Mounting: Fasten fixtures securely to the indicated structural support members of the building. Provide separate supports or mounting clips for all recessed ceiling-mounted lighting fixtures in accordance with the NEC. Check to ensure that solid pendant fixtures are plumb.

E. Appurtenances: Install each fixture properly and safely. Furnish and erect hangers, rods, mounting brackets, supports, frames, and other equipment required.

- F. Coordination: Furnish lighting fixtures complete with appurtenances required for the proper, safe and distortion-free installation in the various surfaces in which they appear. Determine surface types from the Architectural drawings.
- G. Instructions: Each lighting fixture shall be packaged with complete instructions and illustrations showing how to install. Install lighting fixtures in strict conformance with manufacturer's recommendations and instructions.
- H. Continuous Row Fixtures: Rigidly align all continuous rows of lighting fixtures for true in-line appearance.
- I. Pendant Fixtures: Install pendant lighting fixture plumb and at a height above the finished floor as specified in the drawings. In cases where conditions make this impractical, refer to the Architect for a decision. Use ball aligners and canopies on pendant fixtures unless noted otherwise.
- J. Suspended Fixtures:
 - 1. Fixture studs shall be provided in all outlet boxes from which fixtures are suspended. Fixtures shall not be suspended by means of cover or canopy screws. Canopies shall completely cover the ceiling opening of all ceiling fixtures except lay-in fixtures in T-bar construction, and trimless fixtures.
 - 2. Surface-mounted lighting fixtures (i.e. exit lights, etc.) are installed on lay-in panels in T-bar ceiling construction, the outlet boxes shall be rigidly supported to the ceiling system using metal channels spanning perpendicular across the T-bars and securely attached to each side of the outlet box.

VERIFY THE FOLLOWING

- 3. Chain-suspended lighting fixtures shall be connected to the outlet box mounted directly above the fixture using **[flexible metallic conduit], [Type MC cable] [Type "SO" cord]** strapped to the fixture chain. Suspension chain shall be heavy duty nickel or cadmium-plated.
- K. Outlet Boxes: The locations indicated for outlet boxes of lighting fixtures are diagrammatic. Outlets shall be located as required to coincide with suspension hangers where they occur and with structural and architectural elements of the building and shall be located in accordance with the Architectural Reflected Ceiling Plan.
- L. Fixture Designations: If a fixture-type designation is omitted, furnish fixture of the same type as shown for rooms of similar usage. Verify with Engineer before purchase and installation.

VERIFY IS FOLLOWING IS REQUIRED

- M. Installation Sequence: Do not install fixtures or such parts as finishing plates and trims for recessed fixtures until all plastering and painting that may mar fixture finishes has been completed. Install reflector cones, baffles, aperture plates, light controlling elements for air handling fixtures, and decorative elements after completion of ceiling tiles, painting and general cleanup.
- N. Mechanical Rooms: Lighting fixture locations in mechanical and electrical equipment rooms are approximate. Coordinate mounting height and location of lighting fixtures to clear mechanical, electrical and plumbing equipment and to illuminate adequately meters, gauges and equipment. Support all lighting fixtures independently of ductwork, piping and their supports.

- O. Concealment: Whenever a fixture or its hanger canopy is applied to a surface mounted outlet box, a finishing ring shall be utilized as necessary to conceal the outlet box.

[VERIFY THE FOLLOWING]

- P. Wire Guards/Tube Guards: Wire guards or tube guards shall be provided for all fixtures with exposed lamps where installed in mechanical/electrical spaces; in all locations below 8'-0" above finished floor;] [and where lamps are exposed to damage.

[VERIFY IF THE FOLLOWING IS REQUIRED]

- Q. Fluorescent Lighting Fixtures Installed in UL-rated Ceiling Assemblies: Fixtures shall have armored cable or flexible metallic conduit fixture-tails used for connection of lighting fixtures and shall have wiring installed as follows:

1. Shall be wired through the ends of the fixtures, or shall be provided with 90 degree ells on top of the fixtures, to allow the installation of the UL-approved fire-rated covers by the Ceiling Contractor.
2. Failure to provide the required connectors shall not relieve this Contractor of his responsibility for replacing the connectors at no additional cost to the Owner.
3. The UL fire-rated covers shall not be notched by the Ceiling Contractor because of improper wiring connectors installed on the fixtures by this Contractor.
4. This Contractor shall verify with the Architect/Engineer and the Ceiling Contractor, the specific requirements for the type of UL-rated ceiling assembly being installed.

- R. Fusing: Refer to Section 26 28 13, "Low Voltage Fuses", for fusing for HID ballasts.

- S. Fluorescent Emergency Backup Units: For nonswitched applications connect ac input to switched and unswitched unit inputs, unless noted otherwise on Drawings. For switched applications provide a switched ac input to the unit switched input and a nonswitched ac input to the unit nonswitched input.

3.2 AIMING AND ADJUSTMENT:

- A. All adjustable lighting units shall be aimed, focused, locked, etc., by the Contractor under the supervision of the Lighting Consultant. The Lighting Consultant shall indicate the number of crews (foreman and apprentice) required. All aiming and adjusting shall be carried out after the entire installation is complete.
- B. All ladders, scaffolds, etc. required for aiming and adjustment shall be furnished by the Contractor at the direction of the Lighting Consultant. As aiming and adjustment is completed, locking setscrews and bolts and nuts shall be tightened securely.
- C. Units shall be focused during the normal working day, where possible. However, where daylight interferes with precise focusing, aiming shall be accomplished at night.

3.3 CLEANUP:

- A. At the time of final acceptance by the Owner, all lighting fixtures shall have been thoroughly cleaned with materials and methods recommended by the manufacturers, all broken parts shall have been replaced, and all lamps shall be operative. Replace blemished, damaged, or unsatisfactory fixtures as directed by Architect.

3.4 MAINTENANCE:

- A. The Contractor shall be responsible for obtaining from his supplying lighting manufacturers, for each type of lighting fixture, a recommended maintenance information which shall be

included in the Project Operating and Maintenance Manuals. Minimum information shall include:

1. Tools required.
2. Types of cleaners to be used.
3. Replacement parts identification list.
4. Final as-built shop drawings.

3.5 WARRANTY:

- A. The Contractor shall warrant all fixtures, their finishes, and all of their component parts, except ballasts, to be free from defects for a period of one year from date of acceptance, if operated within rated voltage range. Ballasts shall be warranted for 2 years. Fixture installation shall be warranted for one year from the date of acceptance of the installation. During the warrantee period, repair or replacement of defective materials and/or repair of faulty workmanship or installation shall be provided at no cost to the Owner within 10 days of written notice of the defects as recorded and submitted by the Owner and/or Architect.

3.6 TESTING:

- A. General: Upon completion of installation of lighting fixtures and after building circuitry has been energized, apply electrical energy to demonstrate proper operation of lighting fixtures and controls. When possible, correct malfunctioning units at the site, then retest to demonstrate proper operation; otherwise, remove and replace with new units and proceed with retesting.
- B. Lamps: Install all new incandescent lamps just prior to final inspection. Fluorescent and HID lamps may be utilized in the final finishing of the building. Replace gaseous discharge lamps that are defective, show discolorations, or have exceeded more than 1/3 of their rated life, as per Engineer/Owner's records, with new lamps for final inspection.
- C. Preinspection Tasks: Immediately before final inspection, thoroughly clean all fixtures inside and out, including plastics and glassware, adjust all trim to properly fit adjacent surfaces, replace broken or damaged parts and lamp, and test all fixtures for electrical and mechanical operation. Any fixtures or parts of fixtures, which have begun to show signs of rust or corrosion at the time of completion of the job, shall be removed and replaced with properly protected metal parts.

END OF SECTION 26 51 00